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AUGUST 1937

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MONTHLY WEATHER REVIEW

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VOL. 65, No. 8
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AUGUST 1937

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CLIMATE OF THE WEST FRONT OF THE WASATCH PLATEAU IN CENTRAL UTAH[1]

By RAYMOND PRICE and ROBERT B. EVANS[2]

[Associate Forest Ecologist and Assistant Observer, respectively, of the Intermountain Forest and Range Experiment Station, May 1937.]

INTRODUCTION

Increasing demands for intensive use of the mountainous forest and range lands of the West make it imperative that fundamental plans for wild-land management be developed. Before these plans can be drafted satisfactorily a knowledge of the attendant climatic variations is necessary.

The amount of forage that mountain ranges furnish for range livestock is determined, to a large extent, by the climate, particularly in periods of drought. The success of revegetating already depleted mountain areas depends upon proper selection of species and methods to meet climatic conditions. Permanency and stability of valley farms, communities, and cities depend upon the yield of water from mountainous watersheds for irrigation, industrial, and culinary purposes. The uniformity and quantity of this yield are governed, to a large degree, by the climate and its seasonal and annual fluctuations.

A considerable amount of information concerning mountain climate is contained in many reports and publications dealing with special subjects. However, only limited information is available concerning the climate, especially its variation, of the various mountain vegetational zones. Among the chief writers on this subject are: Bates (2), Bates and Henry (3), Henry (4), Pearson (6), and Sampson (7).

This paper presents the important climatic data collected during the 20-year period from 1914 to 1934, within the four main vegetational zones of a valuable mountain region. The study was made in the immediate vicinity of the Great Basin branch of the Intermountain Forest and Range Experiment Station located on the Wasatch Plateau near Ephraim, Utah.

PHYSIOGRAPHIC FEATURES OF THE AREA

The Wasatch Plateau, the northernmost member of the high plateaus of Utah, and a part of the Colorado Plateau province, extends 75 miles from north to south and has a narrow summit, in most cases not more than 6 miles wide. The western front is a great monoclinal flexure, whose strata bend upward to the summit in a single sweep. The angle of sweep is diversified by minor irregularities which are not of such magnitude as to mask the general uplift.

The part of the plateau where the meteorological stations are located breaks off abruptly to the west. The stream in Ephraim Canyon rises at 10,300 feet elevation and drops to 5,900 feet at the edge of San Pitch Valley about 7 miles below, having an average gradient of approximately 630 feet to the mile. The rim of the plateau is notched by erosion so that it appears serrated and streams have trenched back toward the summit giving the plateau a divided appearance (figure 1).

VEGETATION OF THE AREA

From the valley floor to the summit of the plateau, wide variation in the flora is evident. Yet, within certain altitudinal limits the vegetation is strikingly similar and comparatively uniform and may be grouped into the following four vegetational zones: Piñon-juniper, oakbrush, aspen-fir, and spruce-fir.

The piñon-juniper zone, 5,200 to 6,500 feet in elevation, supports scattered stands of piñon (*Pinus edulis*) and juniper (*Juniperus scopulorum*) intermixed with patches of big sagebrush (*Artemisia tridentata*) with an understory of a limited number of grass and weed species.

The oakbrush zone, 6,500 to 8,000 feet in elevation, is characterized by compact stands of scrub oak (*Quercus gambelii*) interspersed with bigtooth maple (*Acer grandidentatum*) and serviceberry (*Amelanchier alnifolia*). Big sagebrush, true mountain mahogany, known locally as "birchleaf mahogany" (*Cercocarpus montanus*), and a moderate number of grass and weed species occupy the relatively small openings.

The aspen-fir zone, 7,500 to 9,000 feet, supports dense stands of aspen (*Populus tremuloides aurea*) interspersed with white fir (*Abies concolor*), Douglas fir (*Pseudotsuga taxifolia*), and Engelmann spruce (*Picea engelmanni*). These timber stands have an understory of snowberry (*Symphoricarpos areophilus*) and grasses and weeds. In the open parks, which are characteristic of this zone, perennial grasses, chiefly mountain brome (*Bromus carinatus*), and weeds are very abundant, sometimes forming a dense cover.

The spruce-fir zone, 9,000 to 11,000 feet above sea level, is chiefly open grasslands dotted with scattered stands of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce. The grasses are chiefly slender wheatgrass (*Agropyron pauciflorum*) and Letterman needlegrass (*Stipa lettermani*). Yellowbrush (*Chrysothamnus lanceolatus*) and "sweet sage" (*Artemisia incompta*), together with weeds, sometimes form a complete cover.

[1] Data collected in cooperation with U. S. Weather Bureau.

[2] Credit is due to Dr. Arthur W. Sampson, University of California, who initiated the study; to C. L. Forsling, Director of Appalachian Forest Experiment Station, under whose direction the study was continued; to Prof. E. W. Nelson, Colorado State College, who collected part of the field data; to J. Cecil Alter, U. S. Weather Bureau, Salt Lake City, and to Dr. George Stewart, Intermountain Forest and Range Experiment Station, who contributed valuable criticism during the preparation of the manuscript.

METEOROLOGICAL STATIONS UNDER STUDY

Four meteorological stations, located in the approximate centers of the four vegetational zones, ranging from the valley floor to near the summit of the plateau, were used in obtaining data in this study. In addition, three short-time record meteorological stations, two of which are located in the aspen-fir zone and the other in the piñon-juniper zone, were used for purposes of comparison (figures 7 and 8).

The location and the description of each meteorological station are listed in table 1.

Sampson (7), who selected the sites for the three upper meteorological stations in 1913, states:

> They are all in the same canyon, and the distance between the lowest and the highest stations in an air line is approximately 5 miles. Owing to the possibility of the results being influenced by the presence of trees and other objects in the vicinity of the physical instruments and growing plants, the stations are all located in the open, on slopes dipping slightly to south, and no vegetation is so close as to cast shadows on the instruments or potometers, except for a few minutes at sunrise and sunset.

TABLE 1.—*Location and description of meteorological stations established on the Wasatch Plateau in central Utah*

Meteorological station	Location	Date established	Slope	Exact elevation	Observer
				Feet	
Piñon-Juniper zone.	Manti, Utah	1892	Flat	5,575	U. S. W. B.
Do	Ephraim, Utah	1930	do	5,543	G. B. B. S. coop. U. S. W. B.
Oakbrush zone	Ephraim Canyon	1914	50° W	7,655	Do.
Aspen-fir zone	do	1914	Slight dip to S. & W.	8,850	Do.
Do	Mount Baldy (12-Mile Canyon).	1923		9,100	Manti N. F. coop. U. S. W. B.
Do	Mammoth (Fairview Canyon).	1920		8,700	Do.
Spruce-fir	Ephraim Canyon near summit.	1914	12° S	10,100	G. B. B. S. coop. U. S. W. B.

NATURE OF RECORDS

Temperature and precipitation records are year-long for the piñon-juniper zone for the 34-year period, 1901–34. Similar records for the oakbrush, aspen-fir, and spruce-fir zones are complete for the seasonal period, May 1 to November 1 since 1913 and 1914. In addition, year-long records of both temperature and precipitation for these three zones are available for the years 1914, 1915, 1916, 1919, and 1920, as well as year-long records of precipitation continuously since 1925.

Correlations made with available precipitation and temperature data of the three upper stations and the existing data at the piñon-juniper station are highly significant. In view of this relationship, normals for a 20-year period for the three higher stations were computed by comparisons with the data at the piñon-juniper station by the method described by Milham (5), making averages for all four stations comparable.

Soil temperature, soil moisture, relative humidity, and cloudiness records were kept for the oakbrush, aspen-fir, and spruce-fir zones and, in the main, are for the seasonal period, May 1 to November 1 since 1924.

CLIMATIC FACTORS

Precipitation.—Precipitation on the plateau area varies widely in amount and character between vegetational zones due to differences in elevation and topography. Records of the average annual precipitation for the four zones are: Piñon-juniper, 11.70 inches; oakbrush, 17.51 inches; aspen-fir, 29.48 inches; and spruce-fir, 28.01 inches (figure 2).

The amount of precipitation increases rapidly from the valley floor to an elevation of approximately 9,000 feet, above which a slight decrease takes place. Annual precipitation increases 2.8 inches, on an average, per thousand feet rise in elevation between the piñon-juniper and oakbrush zones, 10.0 inches between the oakbrush and aspen-fir zones, and decreases 1.2 inches per thousand feet rise in elevation between the aspen-fir and spruce-fir zones. Departures from this annual rate during the year are considerable, the minimum being 0.69 inch in June and the maximum being 8.25 inches in January. These findings agree favorably with former findings of Alter (1), Henry (4), and Pearson (6).

Seasonal precipitation (winter—Oct. 1 to May 1, and summer—May 1 to Oct. 1) shows similar increases. Records of winter precipitation in the four zones follow: Piñon-juniper 7.10 inches; oakbrush, 10.92 inches; aspen-fir, 21.02 inches; spruce-fir, 20.56 inches. Amounts of summer precipitation for the same zones are: Piñon-juniper, 4.60 inches; oakbrush, 6.59 inches; aspen-fir, 8.46 inches; spruce-fir, 7.45 inches. However, the average annual percentage of summer precipitation is greater in the lower zones, being 39 percent in the piñon-juniper, 38 percent in the oakbrush, 29 percent in the aspen-fir, and 27 percent in the spruce-fir zones.

Monthly precipitation fluctuates widely within and between zones. Precipitation is lightest during the month of June and heaviest during March in all zones. A secondary rainy season occurs in this area during July and August followed by a dry period during September. After September, monthly precipitation steadily increases, reaching the annual maximum during March (fig. 2). While the amount of precipitation fluctuates in all zones, the variation is greater in the higher zones. The piñon-juniper zone receives 4.1 percent of its annual total during June and 11.5 percent during March, while in the spruce-fir zone the corresponding proportions are 2.6 percent during June and 15.5 percent during March.

Although seasonal and monthly precipitation data show definite seasonal trends, they are more accurately indicated by 5-day precipitation totals. Such data for the aspen-fir zone for the period May 1 to November 1 indicate continuous heavy precipitation until June 1, with an average of 0.55 inch during the May 26 to May 31 period. Thereafter a decrease takes place. The driest period of the year occurs from June 21 to June 25, when the average precipitation is 0.07 inch. A secondary maximum occurs during the period from July 26 to July 31, when the average is 0.50 inch. Following this period precipitation declines to a secondary minimum of 0.09 inch, which is reached from September 16 to September 20. As winter approaches, the amount of precipitation increases markedly. These precipitation trends hold true in all zones although the amounts differ (table 2).

Individual storms which occur during the summer months throughout the plateau area are usually moderate in the amount of moisture they deposit. The average precipitation per rainy day for the four zones is piñon-juniper, 0.12 inch; oakbrush, 0.21 inch; aspen-fir, 0.20 inch; spruce-fir, 0.20 inch. These totals vary, being greater during May and October in the higher zones and less during the intervening months in the lower zones (table 3).

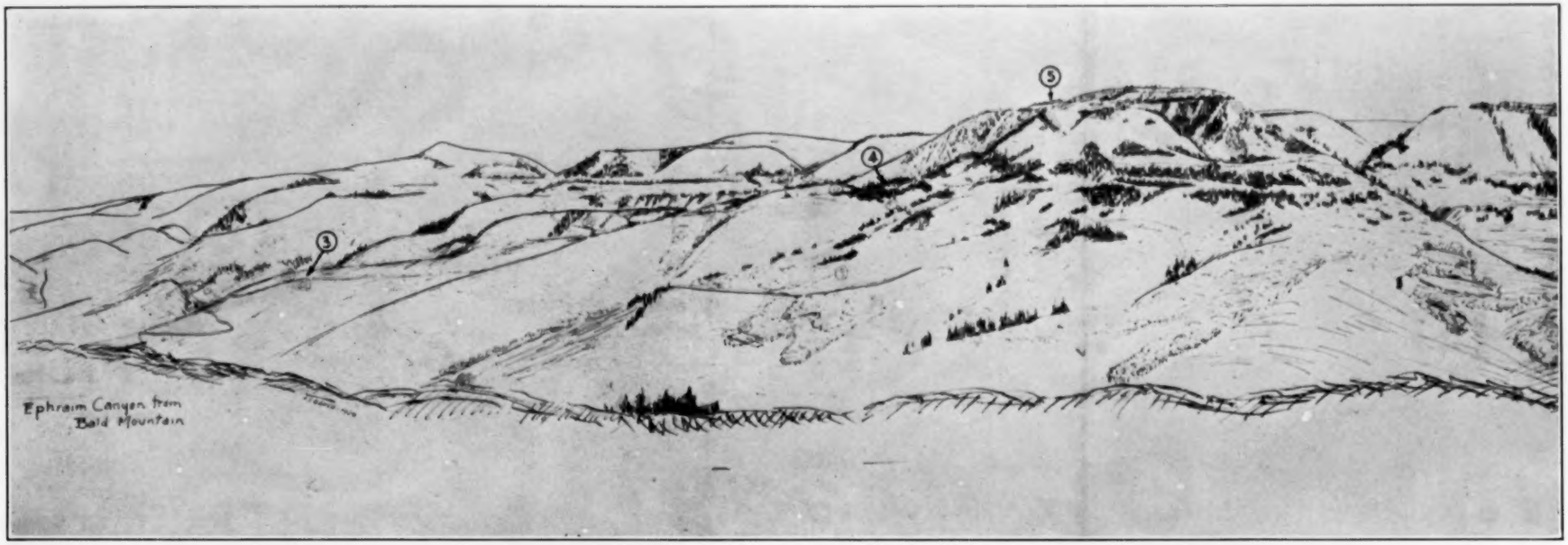

FIGURE 1.—Sketch showing a portion of the west front of the Wasatch Plateau in central Utah, prepared by F. S. Baker, Assoc. Prof. of Forestry, University of California. Circled numbers mark the location of the three upper meteorological stations. (3) = Oakbrush zone meteorological station, elevation 7,655 feet; (4) = Aspen-fir zone meteorological station, elevation 8,850 feet; (5) = Spruce-fir zone meteorological station, elevation 10,100 feet (the spruce-fir zone is located near the main summit in the background which can be seen in the distance).

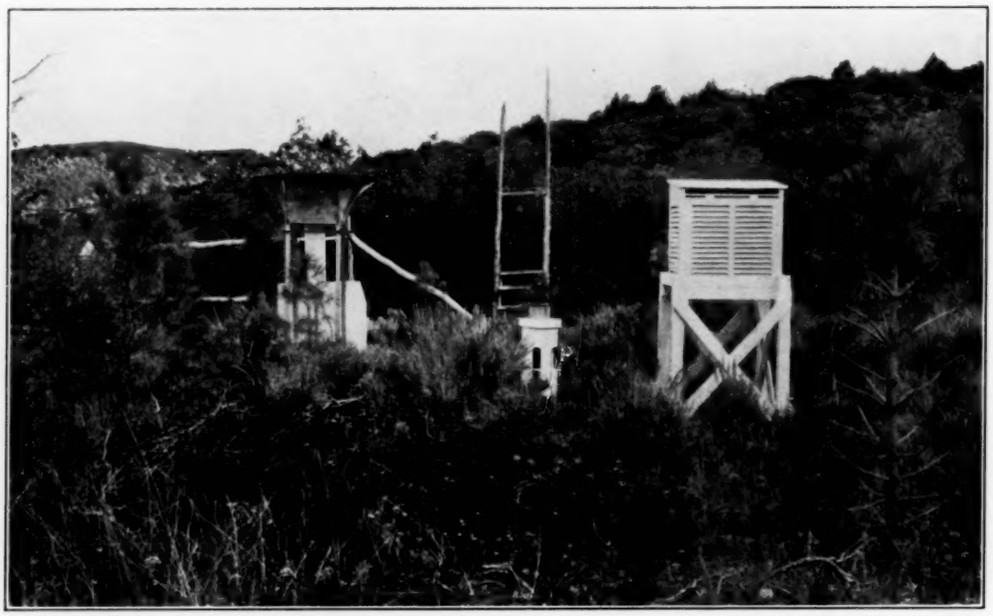

FIGURE 7.—Meteorological station in oakbrush zone in Ephraim Canyon, Utah.

FIGURE 8.—Meteorological station in spruce-fir zone near summit of Wasatch Plateau in Ephraim Canyon, Utah.

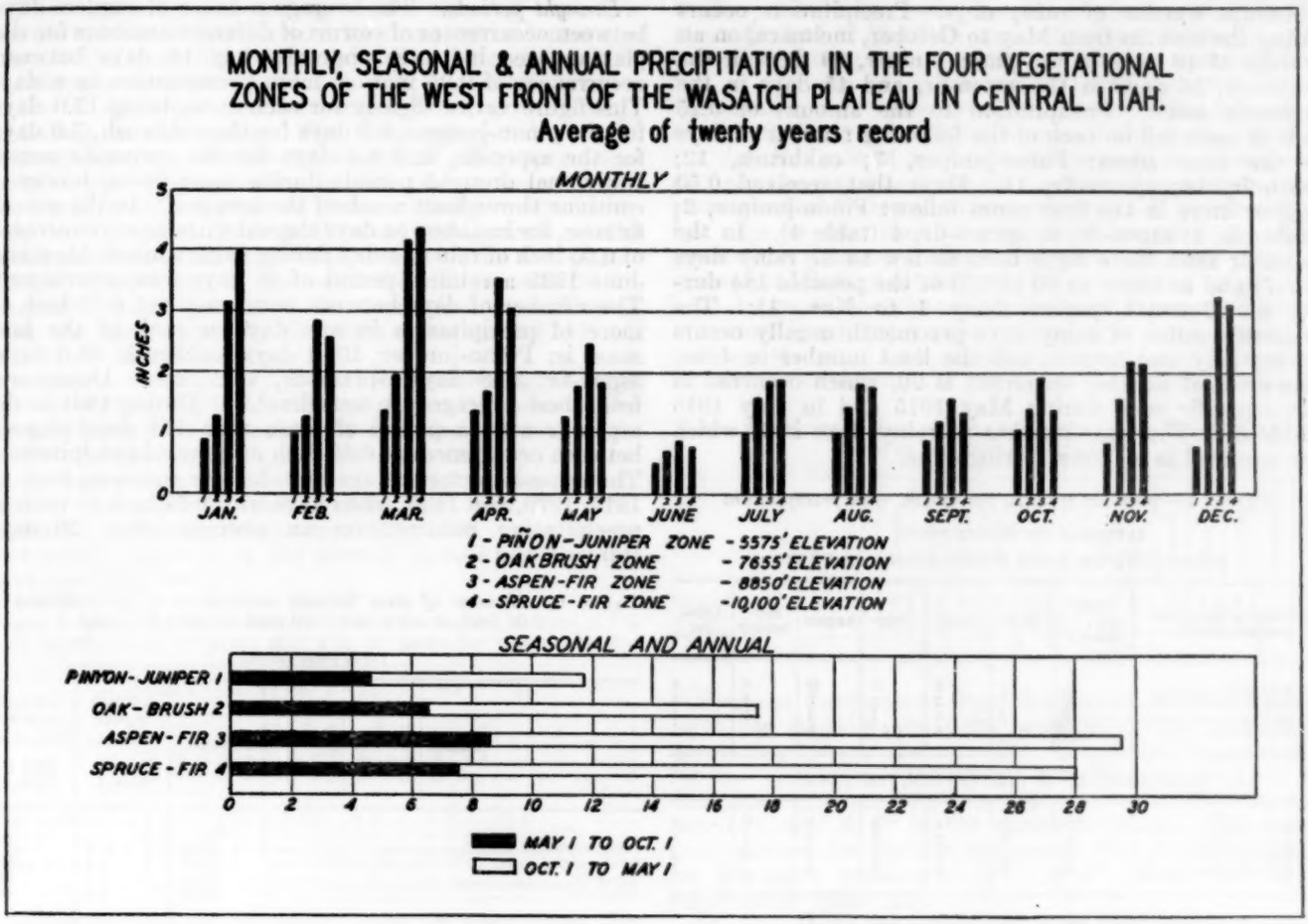
MONTHLY, SEASONAL & ANNUAL PRECIPITATION IN THE FOUR VEGETATIONAL ZONES OF THE WEST FRONT OF THE WASATCH PLATEAU IN CENTRAL UTAH.
Average of twenty years record
MONTHLY
INCHES
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1 - PIÑON-JUNIPER ZONE - 5575' ELEVATION
2 - OAKBRUSH ZONE - 7655' ELEVATION
3 - ASPEN-FIR ZONE - 8850' ELEVATION
4 - SPRUCE-FIR ZONE - 10,100' ELEVATION
SEASONAL AND ANNUAL
PINYON-JUNIPER 1
OAK-BRUSH 2
ASPEN-FIR 3
SPRUCE-FIR 4
MAY 1 TO OCT. 1
OCT. 1 TO MAY 1

FIGURE 2.

TABLE 2.—*Summer precipitation by 5-day periods in four vegetational zones of the west front of the Wasatch Plateau in central Utah*

[Mean of 11 to 20 years' record]

PIÑON-JUNIPER ZONE (ELEVATION 5,575 FEET)

Period	May	June	July	August	September	October
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1–5	0.15	0.14	0.11	0.20	0.16	0.34
6–10	.28	.09	.16	.13	.17	.17
11–15	.14	.07	.18	.18	.15	.17
16–20	.27	.07	.10	.12	.04	.08
21–25	.17	.04	.22	.11	.28	.08
26–31	.25	.08	.20	.23	.09	.21

OAKBRUSH ZONE (ELEVATION 7,655 FEET)

1–5	0.19	0.13	0.12	0.33	0.26	0.27
6–10	.42	.08	.19	.25	.31	.27
11–15	.33	.10	.29	.22	.11	.19
16–20	.25	.10	.06	.14	.07	.16
21–25	.18	.07	.24	.15	.31	.13
26–31	.41	.14	.43	.35	.17	.39

ASPEN-FIR ZONE (ELEVATION 8,850 FEET)

1–5	0.30	0.22	0.22	0.38	0.26	0.45
6–10	.55	.12	.31	.35	.32	.34
11–15	.30	.11	.30	.30	.20	.23
16–20	.41	.18	.21	.18	.09	.18
21–25	.26	.07	.26	.21	.42	.18
26–31	.55	.15	.50	.37	.27	.54

TABLE 2.—*Summer precipitation by 5-day periods in four vegetational zones of the west front of the Wasatch Plateau in central Utah*—Con.

[Mean of 11 to 20 years' record]

SPRUCE-FIR ZONE (ELEVATION 10,100 FEET)

1–5	0.22	0.14	0.21	0.34	0.27	0.31
6–10	.32	.09	.24	.40	.27	.22
11–15	.49	.08	.34	.29	.19	.24
16–20	.28	.13	.25	.20	.09	.16
21–25	.28	.08	.39	.15	.35	.17
26–31	.45	.15	.44	.33	.17	.33

TABLE 3.—*Average precipitation during a rainy day in the vegetational zones of the west front of the Wasatch Plateau in central Utah*

[Rain or melted snow]

Zone	May 1–Nov. 1	May	June	July	August	September	October
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Pinon-juniper (elevation 5,575 feet)	0.12	0.15	0.07	0.09	0.10	0.12	0.17
Oakbrush (elevation 7,655 feet)	.21	.23	.18	.19	.18	.23	.24
Aspen-fir (elevation 8,850 feet)	.20	.24	.14	.15	.17	.21	.27
Spruce-fir (elevation 10,100 feet)	.20	.26	.18	.17	.16	.19	.26

Average number of rainy days.—Precipitation occurs during the months from May to October, inclusive, on an average of 46 days in the piñon-juniper, 39 days in the oakbrush, 54 days in the aspen-fir, and 45 days in the spruce-fir zones. Precipitation to the amount of 0.25 inch or more fell on each of the following number of days in the four zones: Piñon-juniper, 7; oakbrush, 12; aspen-fir, 14; spruce-fir, 11. Days that received 0.50 inch or more in the four zones follow: Piñon-juniper, 2; oakbrush, 4; aspen-fir, 6; spruce-fir, 4 (table 4). In the aspen-fir zone there have been as few as 37 rainy days (1917) and as many as 69 (1915) of the possible 184 during the 6-month period (May 1 to Nov. 1). The greatest number of rainy days per month usually occurs during July and August, and the least number in June. The greatest number on record is 20, which occurred in the aspen-fir zone during May 1915 and in July 1918 (table 5). The least number of rainy days is 1, which has occurred in all zones during June.

TABLE 4.—*Number of days, per month, with precipitation*

[Average of 10 to 20 years' record]

PIÑON-JUNIPER ZONE (ELEVATION, 5,575 FEET)

Number of days with precipitation of—	Total May 1–Nov. 1	May	June	July	August	September	October
Trace or more	46	9	5	10	10	6	6
0.05 inch or more	24	5	2	4	5	4	4
0.25 inch or more	7	2	1	1	1	1	1
0.50 inch or more	2	(1)	0	(1)	0	(1)	1

OAKBRUSH ZONE (ELEVATION, 7,655 FEET)

Trace or more	39	8	4	8	8	5	6
0.05 inch or more	29	7	2	5	6	4	5
0.25 inch or more	12	3	1	2	2	2	2
0.50 inch or more	4	1	0	0	1	1	1

ASPEN-FIR ZONE (ELEVATION, 8,850 FEET)

Trace or more	54	10	6	12	11	8	7
0.05 inch or more	34	6	3	8	7	5	5
0.25 inch or more	14	4	1	2	2	2	3
0.50 inch or more	6	2	(1)	1	1	1	1

SPRUCE-FIR ZONE (ELEVATION, 10,100 FEET)

Trace or more	45	7	4	11	11	7	5
0.05 inch or more	31	5	2	8	7	5	4
0.25 inch or more	11	2	1	2	2	2	2
0.50 inch or more	4	1	(1)	1	1	(1)	1

[1] Less than 0.5 inch day.

TABLE 5.—*Number of days on which precipitation occurred in aspen-fir zone*

Year	Total, May–October	May	June	July	August	September	October
1914				14	6	4	8
1915	69	20	8	8	12	15	6
1916	47	4	1	15	12	5	10
1917	37	10	3	9	8	5	2
1918	68	14	8	20	6	8	12
1919	58	14	2	11	10	12	9
1920	57	4	9	8	14	10	12
1921			6	12	19	2	5
1922			7	8	13	3	6
1923	48	4	5	15	8	7	9
1924	41	6	3	10	8	6	8
1925	68	10	14	16	10	9	9
1926	51	13	7	13	9	5	4
1927	63	5	10	13	11	18	6
1928	47	19	5	3	7	2	11
1929	56	6	3	18	13	9	7
1930	66	10	6	13	17	12	8
1931	47	8	11	6	11	7	4
1932	46	9	6	12	13	4	2
1933	51	14	3	17	7	7	3
1934	39	4	8	7	9	6	5
Average	54.1	10.0	6.1	12.0	10.7	7.5	7.0

Drought periods.—The average number of rainless days between occurrences of storms of different amounts for the plateau area indicates approximately 10 days between occurrences of 0.05 inch or more precipitation in a day. This figure varies slightly for each zone, being 12.0 days for the piñon-juniper, 8.9 days for the oakbrush, 7.6 days for the aspen-fir, and 8.5 days for the spruce-fir zones. Individual drought periods during some years, however, continue throughout much of the summer. In the aspen-fir zone, for instance, 54 days elapsed without an occurrence of 0.05 inch of rain in a day during 1922; while in May and June 1933 a rainless period of 40 days was experienced. The number of days between occurrences of 0.50 inch or more of precipitation in one day for each of the four zones is: Piñon-juniper, 109.1 days; oakbrush, 59.6 days; aspen-fir, 33.8 days; spruce-fir, 40.2 days. Departures from these averages are considerable. During 1931 in the aspen-fir zone a period of more than 158 days elapsed between occurrences of 0.50 inch or more of precipitation. The opposite extremes are recorded for summers such as 1915, 1920, and 1930, when days with 0.50 inch or more of precipitation occurred on an average every 20 days (tables 6 and 7).

TABLE 6.—*Number of days between occurrences of precipitation of 0.05 inch or more and 0.50 inch or more in 1 day*

[10-20 years' record]

Station	Elevation	0.05 inch or more	0.50 inch or more
		May 1–Nov. 1	May 1–Nov. 1
	Feet		
Piñon-juniper	5,575	12.0	109.1
Oakbrush	7,655	8.9	59.6
Aspen-fir	8,850	7.6	33.8
Spruce-fir	10,100	8.5	40.2

TABLE 7.—*Average number of days between occurrences of precipitation in aspen-fir zone*

Year	0.50 inch or more in 1 day	0.05 inch or more in 1 day [1]					
	May 1–Nov. 1	May 1–Nov. 1	May	June	July	Aug.	Sept.	Oct.
1914					3	13	10	13
1915	20.1	8.7	2	14	18	18	8	20
1916	39.0	7.1	30	22	5	5	10	4
1917	23.6	7.6	3	10	12	7	10	43
1918	37.5	6.7	22	5	7	12	4	4
1919	26.1	7.8	17	42	11	6	6	7
1920	19.5	7.2	11	16	8	7	6	7
1921				13	5	3	17	17
1922				27	7	4	28	54
1923	33.2	7.3	8	12	5	6	8	8
1924	24.3	7.1	9	18	12	8	6	5
1925	25.3	5.7	7	7	5	4	6	8
1926	45.2	7.1	5	10	9	7	7	9
1927	35.4	7.7	10	10	7	9	4	25
1928	45.2	9.2	5	22	24	14	12	5
1929	35.0	5.4	12	16	4	4	6	7
1930	19.2	8.0	7	11	8	6	9	13
1931	91.5	10.7	10	19	18	9	5	14
1932	25.6	7.0	6	22	8	5	14	14
1933	29.5	8.7	11	40	8	7	12	20
Average	33.8	7.6	10	18	9	8	9	15

[1] Dry periods extend into other months until precipitation occurs.

Character of precipitation.—The higher the altitude the longer the snowfall period, and consequently the greater the proportion of the annual precipitation occurring as snow. Snowfall constitutes 45 percent of the total annual precipitation in the piñon-juniper, 60 percent in the oakbrush, 70 percent in the aspen-fir, and 80 percent in the spruce-fir zones.

The beginning and ending of the snowfall season is not abrupt but is characterized by storms of both rain and snow. The transition from rainfall to snowfall within the three upper zones occurs during September and October in the fall and from snowfall to rainfall during April, May, and June in the spring. The transition periods in the piñon-juniper zone are March and April in the spring and October and November in the fall. Snow has occurred during all months within all zones but only rarely during July and August. During October 13.5 percent of the total number of storms are snowstorms in the piñon-juniper, 34 percent in the oakbrush, 56 percent in the aspen-fir, and 66 percent in the spruce-fir zones. During May the percentages for the same zones are 2.9, 14, 45, and 84 percent, respectively.

A snow cover is usually present in the three upper zones by November 1. The average maximum depth is reached about March 1 in the oakbrush zone and approximately April 1 in the aspen-fir and spruce-fir zones. On these dates the average depths are 24.9 inches in the oakbrush, 48.5 in the aspen-fir, and 58.5 in the spruce-fir zones (table 8), although depths as great as 39 inches in the first-named zone, 65 in the second, and 84 in the third have been observed.

TABLE 8.—*Depth of snow and water content (in inches); average of 7 to 20 years' record for depth and 4 to 17 years for water content*

Zone	Nov. 1		Dec. 1		Jan. 1		Feb. 1		Mar. 1		Apr. 1		May 1	
	Depth	Water Content	Depth	Water Content	Depth	Water Content	Depth	Water Content	Depth	Water Content	Depth	Water Content	Depth	Water Content
Piñon-juniper	0.1	----	0.8	----	2.2	----	4.1	----	1.5	----	0.8	----	0	----
Oakbrush	3.3	----	6.5	1.53	15.2	3.02	22.3	4.59	24.9	5.89	17.8	5.55	----	----
Aspen-fir	5.0	----	13.9	2.93	27.7	5.51	38.9	8.00	47.3	10.18	48.5	14.56	25.5	8.34
Spruce-fir	5.8	----	19.1	----	31.5	7.37	41.2	10.19	52.9	14.71	58.5	17.28	----	----

Water content of the snow cover, in relation to the depth, increases with the advance of the snowfall season. At the beginning the ratio is 1:5 which increases to 1:3 during April and May when melting occurs in the spring. Water content of the snow cover, in relation to annual precipitation, is 34 percent on March 1 in the oakbrush zone, 49 percent in the aspen-fir, and 62 percent in the spruce-fir zones on April 1.

The date of snow disappearance is delayed on an average of approximately 15.5 days per 1,000 feet rise in altitude. Snow is off, on the average, by April 18 in the oakbrush zone, May 6 in the aspen-fir zone, and May 26 in the spruce-fir zone.

Trend of precipitation.—Considerable periodic variation in annual precipitation is evidenced by the following data taken from records in the piñon-juniper zone at Manti, Utah, during the past 34 years:

1901–04	9.69 inches,	83 percent of normal
1905–09	17.06 inches,	146 percent of normal
1910–22	12.95 inches,	111 percent of normal
1923–30	11.28 inches,	96 percent of normal
1930–34	7.88 inches,	67 percent of normal

During the 12 years 1923 to 1934, only 2 years (1927 and 1930) received above normal precipitation. However, during 4 of the 12 years (1923, 1925, 1927, 1930) summer rainfall was above normal (figure 3).

Temperature.[3]—Temperatures vary greatly between vegetational zones. Annual mean temperatures are 46.9° in the piñon-juniper, 42.6° in the oakbrush, 38.0° in the aspen-fir, and 32.5° in the spruce-fir zones (figure 4). On an average, temperatures decrease 3.2° per thousand feet rise in altitude or approximately 4.8° between zones. Departures from these rates are considerable, depending on the time of day and the season of the year. During the day the rate of variation increases to an average of 4.7° per thousand feet rise at the time of maximum temperatures and decreases to an average of 1.7° per thousand feet rise at the time of minimum temperature. The gradient is greatest during spring when a snow cover is present at the high altitudes but absent in the valley, and least during winter when there is a snow cover on all zones. Maximum gradients for the year occur in April, averaging 4.6° per thousand feet rise and minimum gradients occur in January averaging 1.6° per thousand feet rise (table 9).

TABLE 9.—*Average decrease in temperature per thousand-foot increase in elevation (degrees F.)*

	Annual	January	February	March	April	May	June	July	August	September	October	November	December
In maxima	4.7	3.1	3.6	5.9	6.3	5.6	5.0	4.6	4.6	4.6	4.8	4.4	4.0
In minima	1.7	.0	1.4	2.9	3.0	2.5	1.7	1.6	1.5	1.5	1.5	1.3	1.6
In mean	3.2	1.6	2.5	4.4	4.6	4.0	3.4	3.1	3.0	3.0	3.2	2.8	2.8

Seasonal fluctuations from the annual mean temperatures are considerable, being greatest in the valley and decreasing toward the summit. The mean temperatures for the winter season (October 1 to May 1) are 35.6° in the piñon-juniper, 31.6° in the oakbrush, 27.3° in the aspen-fir, and 21.7° in the spruce-fir zones. The mean temperatures for the summer season May 1 to October 1 for the same zones are: 62.6°, 57.9°, 53.0°, and 47.6° respectively (table 10).

Monthly mean temperatures in the piñon-juniper zone range from 69.5° in July to 23.8° in January, making an annual range of 45.7°. In the spruce-fir zone the means are 55.3° in July and 16.8° in January making an average annual range of 38.5°. Similar fluctuations occur in the intervening zones. The coldest month of record is January in the two lower zones and December in the two higher zones. July is the hottest month of the year in all zones (figure 4).

TABLE 10.—*Mean seasonal temperatures (percent of annual)*

Zone	Elevation	May 1–Oct. 1	Oct. 1–May 1
	Feet	*Percent*	*Percent*
Piñon-juniper	5,575	62.6	35.6
Oakbrush	7,655	57.9	31.6
Aspen-fir	8,850	53.0	27.3
Spruce-fir	10,100	47.6	21.7

Daily fluctuations in temperature are greatest on the valley floor at the base of the plateau and decrease with increase in elevation. The average daily range in temperature is 28.4° in the piñon-juniper zone and 14.7° in the spruce-fir zone. This variation is due to the uniformity of minimum temperatures and the wide spread of maximum temperatures. Annual mean minimum temperatures range less than 8° between the lowest and highest zones, while the annual mean maximum temperatures range more than 21°.

[3] All temperatures Fahrenheit.

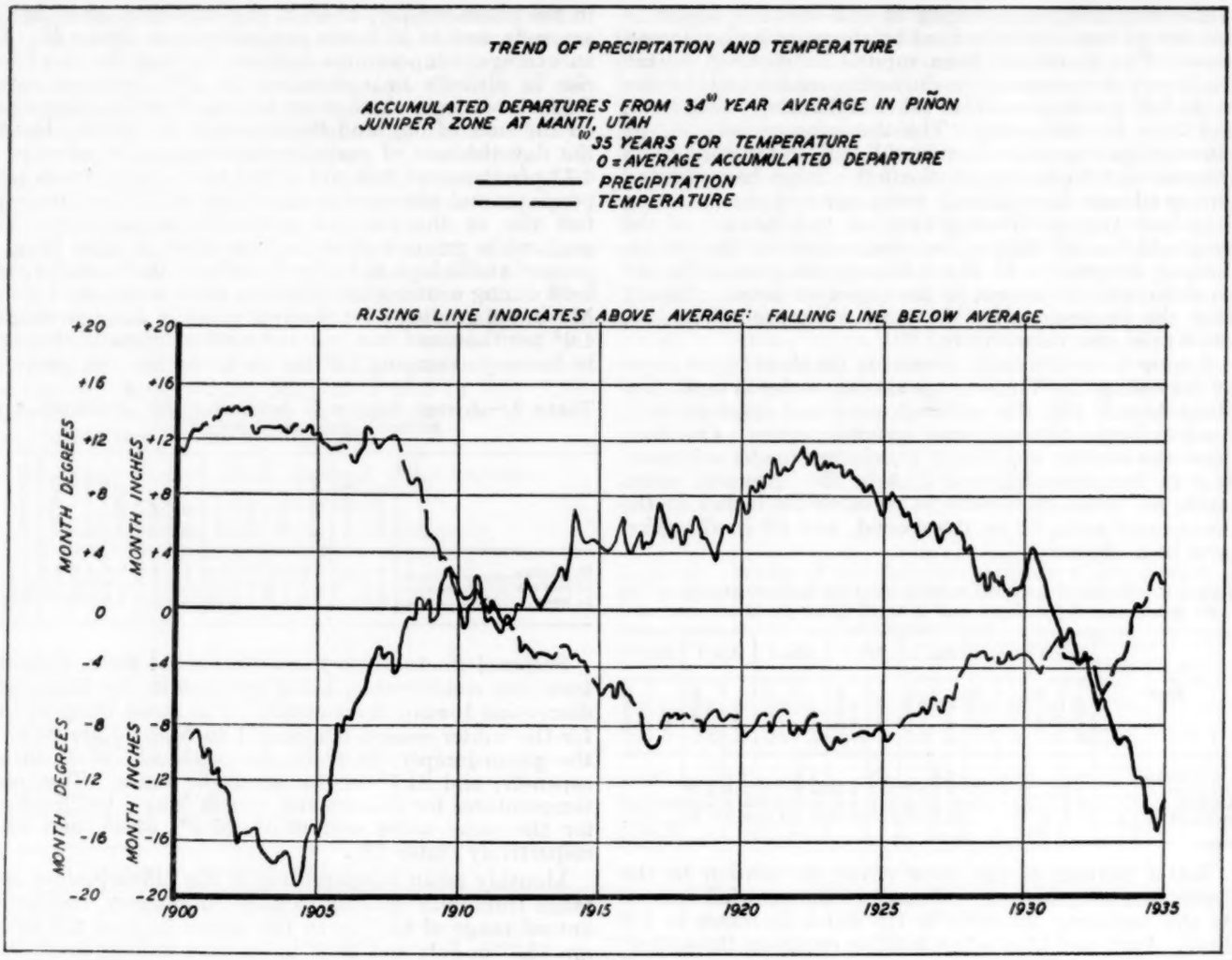

FIGURE 3.

Records for 5-day periods show that temperatures in all zones increase steadily throughout the early spring and summer, reaching the seasonal maximum during the period July 16 to 20; thereafter, temperatures decline throughout the remainder of the summer (table 11).

Extremes in temperature.—Highest temperatures of record range from 82° in the spruce-fir zone to 101° in the piñon-juniper zone. The absolute maximum temperature for the oakbrush zone is 97° and for the aspen-fir zone 88°. Temperatures above 90° are unknown in the aspen-fir and spruce-fir zones but they have occurred during June, July, and August in the oakbrush and piñon-juniper zones. Below-zero temperatures have been recorded during 6 months in the piñon-juniper zone, 7 months in the oakbrush and aspen-fir zones and 8 months in the spruce-fir zones (table 12).

TABLE 11.—*5-day mean temperature normals*

Zone	Elevation	Period	May	June	July	Aug.	Sept.	Oct.
	Feet		° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*
Piñon-juniper	5,575	1–5	51	57	68	68	63	53
		6–10	50	61	69	67	62	53
		11–15	53	63	70	68	60	49
		16–20	57	63	71	67	60	49
		21–25	56	67	70	67	57	48
		26–31	56	68	70	65	55	44
Oakbrush	7,655	1–5	43	53	64	65	60	49
		6–10	42	56	64	64	58	47
		11–15	46	59	66	64	56	43
		16–20	50	58	67	64	56	42
		21–25	49	63	67	64	51	41
		26–31	49	63	66	62	51	38
Aspen-fir	8,850	1–5	39	48	59	59	55	43
		6–10	40	51	60	59	53	41
		11–15	43	53	61	58	52	40
		16–20	44	55	61	58	49	38
		21–25	45	57	61	58	48	36
		26–31	46	59	60	56	45	36
Spruce-fir	10,100	1–5	32	42	54	54	50	39
		6–10	33	45	55	54	48	37
		11–15	35	47	56	54	47	35
		16–20	37	50	56	54	45	34
		21–25	38	52	56	53	43	32
		26–31	39	54	55	52	40	32

TABLE 12.—*Extreme annual and monthly temperatures from 20-year record*[1]

	Annual	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maxima													
Piñon-juniper, elevation 5,575 feet	°F. 101	°F. 63	°F. 24	°F. 77	°F. 80	°F. 87	°F. 96	°F. 101	°F. 99	°F. 90	°F. 82	°F. 73	°F. 59
Oakbrush, elevation 7,655 feet	97	63	59	64	74	83	97	96	91	87	80	71	66
Aspen-fir, elevation 8,850 feet	88	58	56	56	70	73	86	88	84	77	70	59	60
Spruce-fir, elevation 10,100 feet	82	49	53	43	52	66	77	82	76	71	67	55	48
Minima													
Piñon-juniper, elevation 5,575 feet	−26	−22	−26	0	12	18	27	32	34	25	11	−8	−21
Oakbrush, elevation 7,655 feet	−30	−24	−30	−11	−4	11	17	23	23	14	5	−14	−24
Aspen-fir, elevation 8,850 feet	−30	−20	−30	−14	−7	4	19	23	26	11	2	−13	−20
Spruce-fir, elevation 10,100 feet	−21	−21	−20	−12	−5	5	14	29	20	11	−1	−16	−14

[1] Winter extremes in upper zones for fewer number of years.

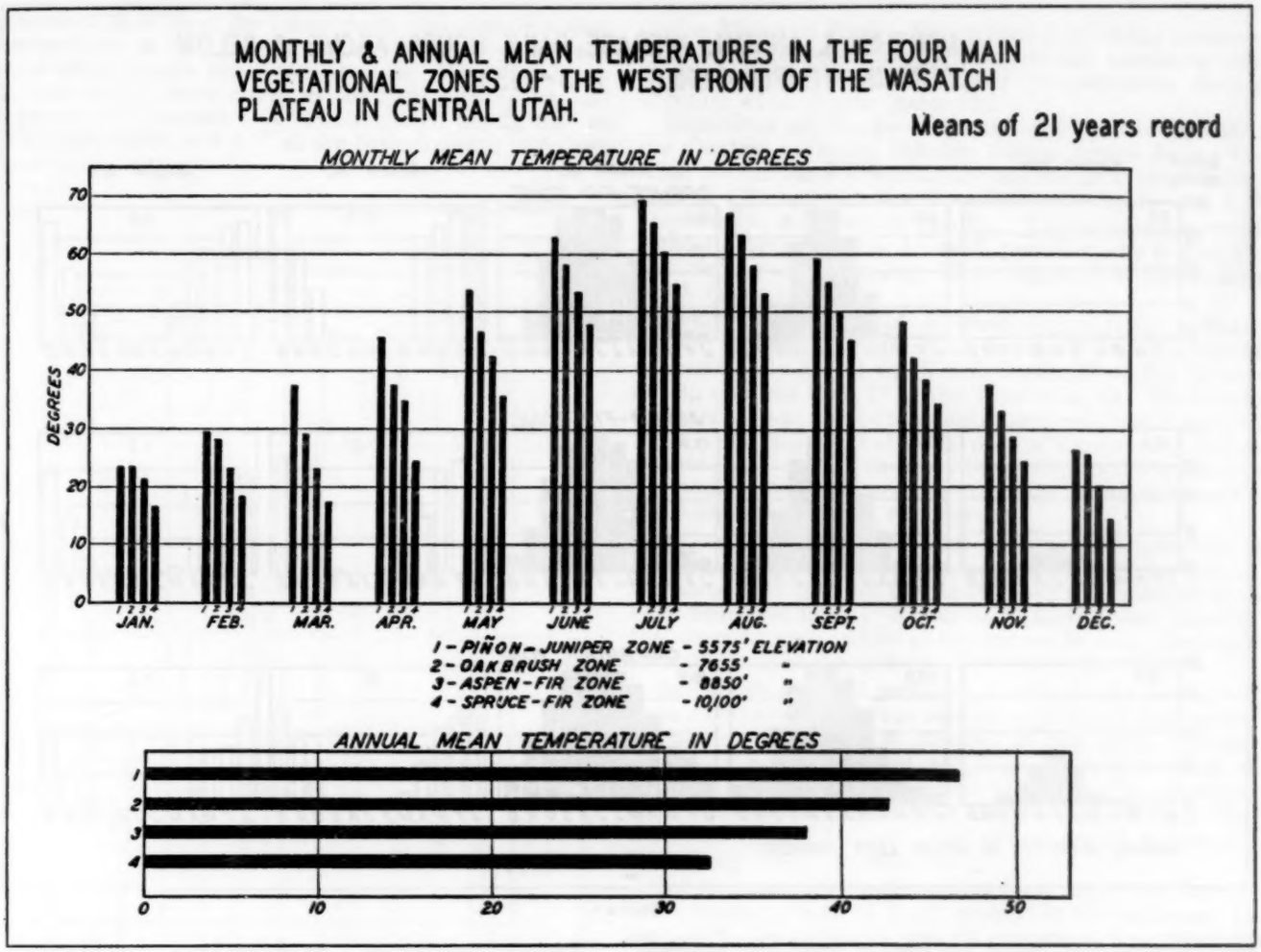

FIGURE 4.

Length of frost-free periods.—Average lengths of the frost-free period (when temperatures are above 32°) in the three upper zones are nearly uniform, being 90 days for the oakbrush, 87 days for the aspen-fir, and 80 days for the spruce-fir zones. Departures from these averages are considerable, the frost-free season having been as short as 53 days and as long as 122 days in the oakbrush zone, during the period of record. The average dates of the last temperatures of 32° occurring in the spring are May 28 for piñon-juniper, June 17 for oakbrush and aspen-fir, and June 18 for spruce-fir zones. The first temperature of 32° occurring in the fall for the same zones are: Sept. 25, Sept. 15, Sept. 12, and Sept. 6, respectively. The latest date on record of a temperature of 32° or lower in the spring is July 12, which occurred in the spruce-fir zone, and the earliest temperature of 32° or lower in the fall is August 16, which occurred in the spruce-fir zone (table 13).

Considerable variation exists between zones in the length of the period when minimum temperatures average above 32°. Such periods are 146 days in the oakbrush, 140 days in aspen-fir, and 110 days in the spruce-fir zones. Although this period is shortest in the spruce-fir zone, it is less disrupted by occasional frosts at the beginning and ending of the season (table 14).

TABLE 13.—*Dates of last temperature of 32° F. in spring, first in fall, and length of frost-free period (1913–33 record)*

	Date of last 32° temperature in spring				Date of first 32° temperature in fall				Length of frost-free period			
	Piñon-juniper	Oak-brush	Aspen-fir	Spruce-fir	Piñon-juniper	Oak-brush	Aspen-fir	Spruce-fir	Piñon-juniper	Oak-brush	Aspen-fir	Spruce-fir
Earliest	Apr. 29	May 30	May 30	June 1	Sept. 10	Aug. 27	Aug. 20	Aug. 16				
Latest	July 3	July 9	July 7	July 12	Oct. 19	Oct. 6	Oct. 5	Sept. 22				
Average	May 28	June 17	June 17	June 28	Sept. 25	Sept. 15	Sept. 12	Sept. 6	120	90	87	80
Longest									147	122	114	111
Shortest									79	53	61	54

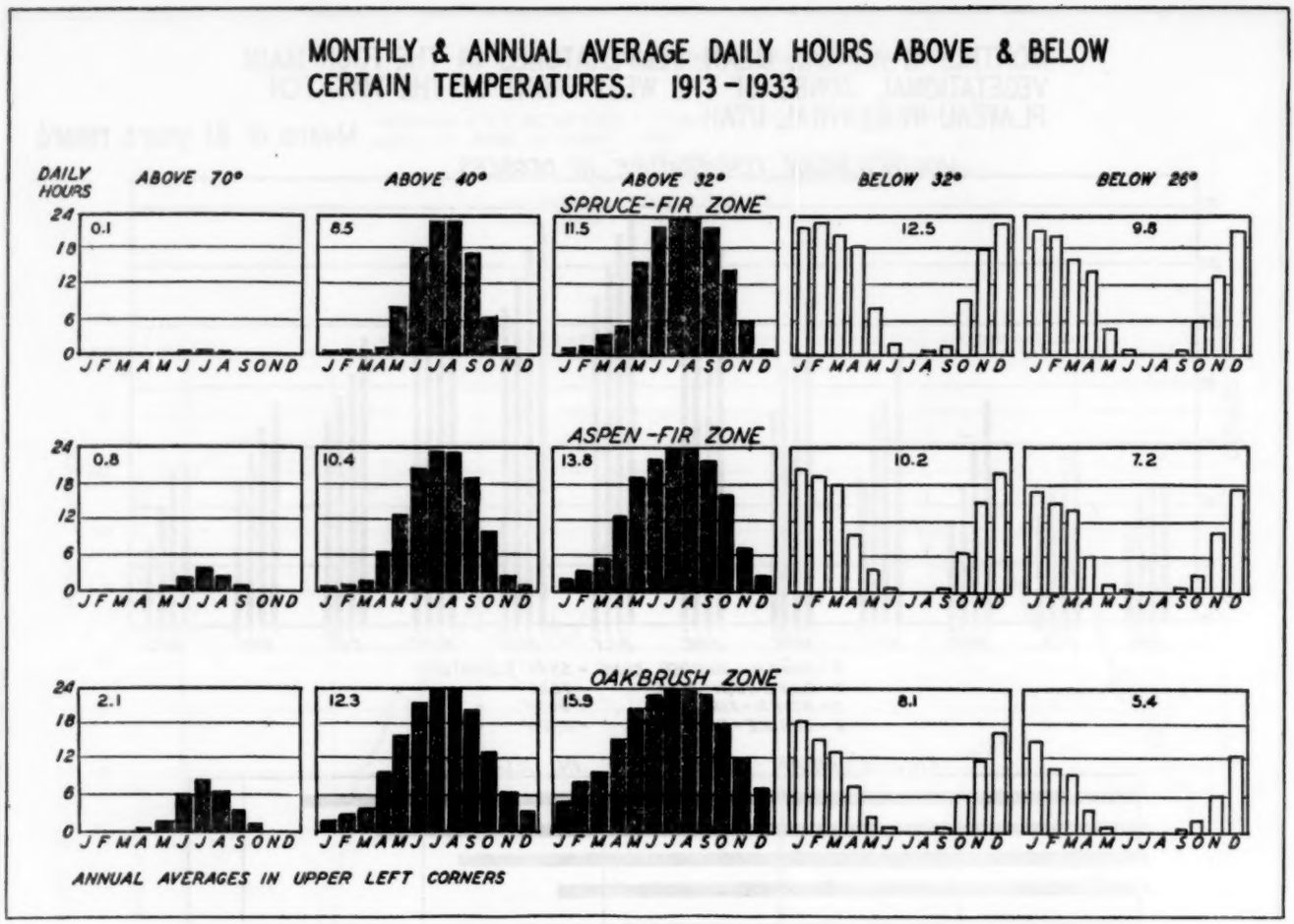

FIGURE 5.

TABLE 14.—*Beginning, ending, and length of period when minimum temperatures average above 32° F. (average of 1913–33 record)*

	Piñon-juniper	Oak-brush	Aspen-fir	Spruce-fir
Date when minimum temperatures average above 32° in spring	----------	May 15	May 16	June 9
Date when minimum temperatures average below 32° in fall	----------	Oct. 8	Oct. 3	Sept. 27
Length of period (number of days) when minimum temperatures average above 32°	----------	146	140	110

Number of hours above and below certain temperatures.—The average number of daily hours with temperatures above 32°, above 40°, and above 70°, are greater in the oakbrush zone and decrease proportionally in the aspen-fir and spruce-fir zones. Conversely, the number of daily hours below 26° and below 32° is greater in the spruce-fir zone and decreases in the two lower zones. The average number of daily hours above 32°, on an annual basis, are 15.9 for the oakbrush, 13.8 for the aspen-fir, and 11.5 for the spruce-fir zones, while the number of hours below 32° are 8.1, 10.2, and 12.5, respectively, for the same zones (figure 5).

Trend of temperature.—As shown by a 34-year temperature record in the piñon-juniper zone, above-normal temperatures generally accompany below-normal precipitation; and below-normal temperatures are associated with above-normal precipitation (figure 3). During the period 1901 to 1904 precipitation was below normal and temperatures were above. On the other hand, during the period 1905 to 1909 precipitation was above normal and temperatures were below. Similar variations occurred during the periods 1910 to 1922, 1923 to 1930, and 1930 to 1934.

OTHER FACTORS STUDIED

(Oakbrush, aspen-fir, and spruce-fir zones)

Soil temperature.—Soil temperatures at depths of 6, 12, and 24 inches fluctuate with air temperatures. During the winter snowfall period temperatures are nearly uniform at these three depths. After disappearance of snow in the spring, and during the summer, temperatures are highest at the shallower depths, while during the fall and winter the opposite holds true. Observations made during one winter, 1915–16, in the aspen-fir zone, indicated a tem-

perature of 32.0° F. at the 6-inch depth and slightly higher temperatures at the two lower depths throughout the period when a snow cover was present. With the disappearance of the snow cover in the spring (May 8), soil temperatures increased 10.4° at the 6-inch depth, 6.1° at the 12-inch depth, and 3.5° at the 24-inch depth in 5 days (figure 6).

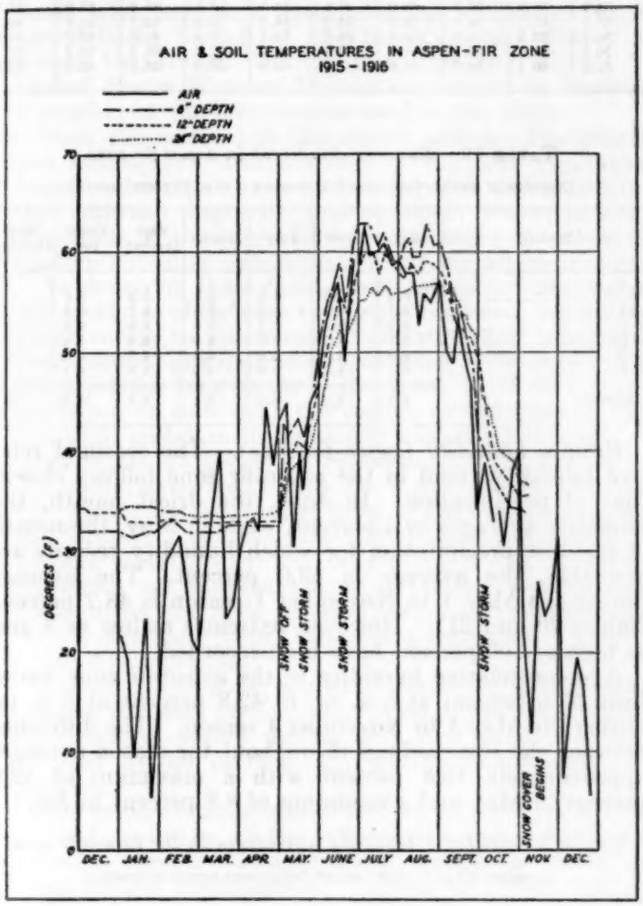

FIGURE 6.

Monthly means of soil temperatures in the aspen-fir zone for the May 1–November 1 period show that average temperatures are highest during July at the 6- and 12-inch depths and highest during August at the 24-inch depth. Average temperatures at the three depths rise steadily during May and June. Throughout August the temperatures average very close to the seasonal maximum and during September and October temperatures decline abruptly at all depths (table 15).

Records of soil temperatures at 5-day periods show that the greatest variation between depths occurs during the latter part of June at which time there is an average difference of 4.5° between the 6- and 12-inch depths and 5.2° between 12- and 24-inch depths. Temperatures average highest during the July 16 to 31 period at the 6- and 12-inch depths and from July 26 to August 5 at the 24-inch depth (table 16).

Hourly observations of soil temperatures (1913) indicate that on an average summer day there is a diurnal range of approximately 12° at the 6-inch depth, 3° at the 12-inch depth, and less than 1° at the 24-inch depth. Maximum temperatures at the 6-inch depth occurred from 6 p. m. to 7 p. m., or 4 to 5 hours after the peak of the air temperature was reached. At the 12- and 24-inch depths the maximum soil temperatures showed similar lags of approximately 10 hours and 24 hours, respectively.

Soil temperature data taken at infrequent intervals in the oakbrush and spruce-fir zones indicate similar trends. The data show that soil temperatures in the oakbrush zone vary from less than 1° higher to 2° higher than those in the aspen-fir zone, while at the spruce-fir zone they vary from 9° lower in the spring to 3° lower in the fall.

Soil moisture.—Soil moisture is not usually considered to be a climatic factor; but because it is largely determined by climatic factors, it is included in this study. Determinations were made on an oven dry-weight basis at depths of 6, 12, and 24 inches (18 inches at spruce-fir zone) similar to the method outlined by Weaver and Clements (8; *pp. 185–188*) and are expressed as percentages of dry weight of samples.

Soil moisture during the season from June 1 to November 1 averages from 15 to 17 percent in the oakbrush, 19 percent in the aspen-fir, and 20 percent in the spruce-fir zones. Percentages as low as 6 and as high as 51 have been recorded, but more ordinary extremes are 15 and 40 percent (table 17).

Variation in this factor between zones is greatest at the beginning of the season (May and June) when a snow cover is yet present at the spruce-fir zone, and gradually decreases throughout the summer period until the difference in October is 4 percent or less at all depths. The oakbrush zone has the least amount of soil moisture, ranging from 0 percent to 12 percent below amounts of the aspen-fir and spruce-fir zones which have similar percentages.

TABLE 15.—*Monthly means*[1] *of soil temperatures in the aspen-fir zone*

Period	May			June			July			August			September			October		
	6 inches	12 inches	24 inches	6 inches	12 ineches	24 inches	6 inches	12 inches	14 inches	6 inches/	12 inches	24 inches	6 inches	12 inches	24 inches	6 inches	12 inches	24 inches
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1924				59.1	55.2	49.9	64.0	61.5	56.8	63.9	61.4	57.5	54.6	54.7	54.1	39.9	41.6	44.2
1925	53.0	49.0	44.2	53.2	51.0	48.2	62.1	59.2	54.7	59.5	58.0	55.3	51.5	52.0	51.6	39.7	41.4	44.0
1926	49.1	46.3	42.9	61.0	57.4	52.4	62.8	59.6	55.2	64.1	61.4	57.4	55.1	54.9	54.2	43.2	44.6	46.2
1927				57.2	53.8	49.0	62.3	59.3		60.2	58.4		52.0	52.0		41.9	42.9	
1928	48.2	44.8		55.9	53.3	49.8	63.7	60.6	56.0	63.8	61.7	58.6	57.3	56.6	55.7	43.3	45.0	47.5
1929				55.1		46.7	61.2	58.4	54.5	59.3	57.4	54.7	50.5	50.1	50.2	43.8	44.6	46.2
1930				56.3	53.1	49.0	62.8	59.4	55.4	58.7	56.9	55.0	50.7	50.9	51.5	38.6	39.6	41.9
1931				59.7	54.7	50.2	68.0	62.8	57.5	64.8	61.5	58.1	55.7	55.3	54.6	44.0	45.3	46.7
1932	46.9	43.0	40.0	57.2	52.3	48.4	62.7	59.2	55.4	59.7	58.2	55.8	52.3	52.5	52.2	40.3	43.1	45.1
1933				59.6	53.2	47.2	64.5	60.7	56.3	62.2	59.5	56.8	56.7	55.6	54.2	44.8	46.2	47.4
1934	54.8	51.8	48.1	56.2	53.8	51.1	65.2	61.8	57.8	62.7	60.9	58.4	55.5	55.7	55.3	44.0	45.8	47.4
Average	50.4	47.0	43.8	57.3	53.8	49.3	63.6	60.2	56.0	61.7	59.6	56.8	53.8	53.7	53.4	42.1	43.6	45.7

[1] Average of 8 a. m. and 5 p. m. readings.

TABLE 16.—*Mean soil temperatures [1] at three depths by 5-day periods in aspen-fir zone (average of 3 to 11 years' record)*

Period	May			June			July			August			September			October		
	6 inches	12 inches	24 inches	6 inches	12 inches	24 inches	6 inches	12 inches	24 inches	6 inches	12 inches	24 inches	6 inches	12 inches	24 inches	6 inches	12 inches	24 inches
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1–5	42.9	41.2	39.1	52.0	49.3	45.0	62.8	59.1	54.4	62.8	60.5	57.1	58.8	57.3	55.8	45.9	47.0	48.7
6–10	46.2	43.2	41.3	53.6	50.6	46.3	62.3	59.1	55.0	61.5	59.5	56.6	56.8	56.1	55.1	45.1	46.0	47.6
11–15	48.4	44.8	41.6	56.8	52.9	48.5	63.1	59.6	55.3	61.7	59.4	56.6	54.6	54.2	53.8	42.3	44.1	46.3
16–20	50.5	46.6	43.1	57.9	54.6	50.0	64.9	61.2	56.2	62.2	59.8	56.8	54.6	54.1	53.4	41.0	42.7	44.8
21–25	51.1	48.0	44.5	61.3	56.8	51.6	64.2	61.1	56.8	62.4	59.8	56.8	50.8	51.7	52.2	39.3	41.3	43.4
26–31	50.8	49.3	45.0	62.1	58.2	53.3	64.1	61.3	57.3	60.1	58.7	56.6	47.5	48.8	50.0	38.2	40.3	42.6

[1] Average of 8 a. m. and 5 p. m. readings.

Soil-moisture percentages fluctuate more widely near the surface than at deeper levels due to weather changes. For instance, in May, June, and July 1933, during a 39-day drought, soil moisture decreased 22.0 percent within 6 inches of the surface, 11.6 percent in the 6-inch depth, and 10.9 percent in the 12-inch to 24-inch depth. A storm of 1.03 inches of rain followed this drought period and 3 days later, increases in soil moisture of 9.6 percent were indicated by the samples for the 0- to 6-inch depth; 3.0 percent for the 6- to 12-inch depth; and 0.7 percent for the 12- to 24-inch depth.

TABLE 17.—*Average soil-moisture percentages, means of 3 to 11 years' record, in percent of dry weight of soil*

Zone	Depth	June 1–Nov. 1	May	June	July	Aug.	Sept.	Oct.
	Inches	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Oakbrush	0– 6	15	25	15	13	14	15	16
	6–12	16	27	21	16	16	16	15
	12–24	17	26	21	16	16	16	15
Aspen-fir	0– 6	19	28	22	19	19	21	20
	6–12	19	31	25	19	19	20	18
	12–24	19	31	26	20	19	19	16
Spruce-fir	0– 6	20	-------	27	21	21	21	16
	6–12	20	-------	28	22	20	21	16
	12–18	20	-------	28	22	20	19	16

Cloudiness (Piñon-juniper and aspen-fir zones).—Average daily cloudiness as indicated by eye observations for the piñon-juniper and aspen-fir zones is 5.7 and 5.4 tenths of the sky, respectively. Cloudiness is at a maximum in both zones during the winter and early spring and is least in late spring and fall.

Records of cloudiness for 5-day periods in the aspen-fir zone indicate considerable variation throughout the summer season (May 1–Nov. 1). Cloudiness varies from a maximum of 6.2 tenths in middle and late May to a minimum of 3.3 tenths in late June, and to 4.1 tenths during the latter part of October (tables 18 and 19).

TABLE 18.—*Average daily cloudiness in piñon-juniper and aspen-fir zones*

[Number of tenths of sky clouded; average of 4 to 20 years' record]

Zone	Annual	January	February	March	April	May	June	July	August	September	October	November	December
Piñon-juniper	5.7	5.8	6.0	6.0	6.2	6.2	5.3	5.7	6.1	5.4	5.2	5.4	5.5
Aspen-fir	5.4	7.0	6.0	4.4	6.1	6.1	4.5	5.2	5.1	4.6	4.8	6.5	5.0

TABLE 19.—*Summer cloudiness in aspen-fir zone*

[Number of tenths of sky clouded; average of 10 to 20 years' record]

Period	May	June	July	August	September	October	May–October
1–5	6.1	5.3	4.3	5.3	5.2	6.0	-------
6–10	6.1	4.9	5.3	5.2	4.7	5.3	-------
11–15	6.2	5.1	5.1	5.6	3.8	4.9	-------
16–20	5.7	4.7	5.3	4.9	4.4	4.4	-------
21–25	6.2	3.3	5.6	4.4	4.7	4.2	-------
26–31	6.1	4.0	5.6	4.9	4.6	4.1	-------
Average	6.1	4.5	5.2	5.1	4.6	4.8	5.1

Relative humidity (aspen-fir zone).—The seasonal relative humidity trend in the aspen-fir zone follows closely that of precipitation. In June, the driest month, the humidity averages 39.5 percent, while in May, the month of greatest precipitation for which humidity records are available, the average is 53.0 percent. The average during the May 1 to November 1 season is 48.2 percent (tables 20 and 21). However, extremes as low as 4 and as high as 100 percent have been recorded.

Average relative humidity in the aspen-fir zone varies from 53.6 percent at 8 a. m. to 42.8 percent at 5 p. m. during the May 1 to November 1 season. The difference between the two readings throughout the season averages approximately 10.8 percent with a maximum of 12.9 percent in May and a minimum of 8.8 percent in July.

TABLE 20.—*Relative humidity percentages in the aspen-fir zone*

[Average of 6 to 12 years' record; 100 percent equals saturation]

	May 1–Nov. 1	May	June	July	Aug.	Sept.	Oct.
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
8 a. m.	53.6	59.4	44.6	53.4	54.7	53.7	56.1
5 p. m.	42.8	46.5	34.4	44.6	43.5	43.1	44.5
Mean	48.2	53.0	39.5	49.0	49.1	48.4	50.3

TABLE 21.—*5-day mean [1] percentages of relative humidity in the aspen-fir zone*

[Average of 3 to 12 years' record; 100 percent equals saturation]

Period	May	June	July	Aug.	Sept.	Oct.
	Percent	Percent	Percent	Percent	Percent	Percent
1–5	63	43	43	53	49	52
6–10	61	39	47	50	48	49
11–15	58	41	48	48	45	54
16–20	60	39	48	49	44	53
21–25	46	36	49	46	49	45
26–31	44	37	55	49	55	44

[1] Average of 8 a. m. and 5 p. m. readings.

SUMMARY AND CONCLUSIONS

Climatic data presented in this study were collected during the 20-year period, 1914 to 1934, within the four main vegetational zones, designated as piñon-juniper, oakbrush, aspen-fir, and spruce-fir, ranging in elevation from 5,575 feet to 10,100 feet, on the west front of the Wasatch Plateau in central Utah. Observations were made with standard meteorological equipment by the Great Basin branch of the Intermountain Forest and Range Experiment Station, near Ephraim, Utah. The United States Weather Bureau cooperated in furnishing a number of the instruments used in the study.

Data summarized in this report include: Precipitation and atmospheric temperatures in the four vegetational zones; soil temperatures and amounts of soil moisture in the oakbrush, aspen-fir, and spruce-fir zones; extent of cloudiness in the piñon-juniper and aspen-fir zones; and relative humidity determinations in the aspen-fir zone.

As shown by these data, precipitation and atmospheric temperatures of the area vary widely between vegetational zones, owing to differences of elevation and topography. Total annual precipitation varies from 11.70 inches in the piñon-juniper zone on the valley floor, to 29.48 inches in the aspen-fir zone near the middle of the plateau front, and 28.01 inches in the spruce-fir zone at the summit. Of these totals, 45 percent, 70 percent, and 80 percent, respectively, is received during the winter season, November 1 to May 1, in the form of snow. The remainder falls in the form of moderate rains distributed throughout the summer season, May 1 to November 1. Summer thunderstorms are interspersed with rainless periods which occur during the main growing season and have extended for 158 days, and longer, between occurrences of 0.50 inch or more precipitation.

The month of June, a critical period for plant growth, receives the least precipitation in all zones. A secondary rainy season occurs during July and part of August, followed by an extreme dry period that extends into October.

The trend of precipitation for the 34-year period, 1901 to 1934, inclusive, at the piñon-juniper zone shows considerable periodic variation characterized by above- and below-normal precipitation. Consecutive years with below-normal precipitation have numbered as many as 12 during this time.

Temperatures as high as 101° F. have been recorded in the piñon-juniper zone and as low as −30° in the oakbrush and aspen-fir zones.

The growing season within the area is extremely short, the frost-free period being only 90 days in the oakbrush, 87 days in the aspen-fir, and 80 days in the spruce-fir zones.

In view of the limited amount and sporadic nature of precipitation and the extremes in atmospheric temperatures during the short growing season, plans for proper management of this area must recognize the delicate balance between this existing climate and the vegetational cover and provide for moderate grazing use and controlled timber-cutting practices.

Such a program will maintain an adequate plant cover which will guard against serious soil erosion and insure a permanent water supply sufficient to meet the needs of the adjacent communities. Also, records of the existing climate indicate that areas already depleted of plant cover can be rehabilitated only by controlled grazing use and by planting forage species especially adapted to withstand the drought periods and extreme fluctuations in temperature characteristic of this area.

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THE GEOMETRICAL THEORY OF HALOS—V

By EDGAR W. WOOLARD

[Weather Bureau, Washington, D. C., September 1937]

IMAGES PRODUCED BY SIMPLE REFLECTION

Superimposing figure 7 on the celestial sphere, we have figure 17 and formulae D for the calculation of an image produced by simple reflection from an arbitrarily oriented plane with normal inclined at any angle ψ' to the vertical.

When the reflecting plane is vertical, $\psi'=90°$ and

$$\begin{aligned} D&=180°-2i,\\ \cos A'&=\tan\frac{D}{2}\tan H, \qquad (D^*)\\ H'&=H,\\ \sin\frac{\zeta}{2}&=\sin\frac{D}{2}\sec H, \end{aligned}$$

as may be found either directly from formulae D or by constructing the corresponding special case of figure 17. The rotation of a vertical plane about a vertical axis will therefore distribute the reflected light in a right cone with vertical axis and with one of its generators parallel to the incident ray; the locus of the images formed by this conical dispersion is a small circle parallel to the horizon.

When the reflecting plane is horizontal $\psi'=0°$, $i=90°-H$; and either from formulae D or directly from figure 7,

$$\begin{aligned} D&=2H,\\ A'&=180°, \qquad (D^{**})\\ H'&=-H,\\ \zeta&=0°. \end{aligned}$$

The rotation of a horizontal plane about a vertical axis will not disperse the reflected light at all, but will merely form a vertical image as far below the horizon as the source is above.

IMAGES PRODUCED BY PRISMATIC REFRACTION COMBINED WITH INTERNAL REFLECTION

In the most general case of *reflection from an arbitrary plane* (figure 11), with the *refracting edge in any position*, we may use formulae *C* (figure 16) except of course that the angles D', D, and A will be obtained from formulae III instead of from I. When $\psi=0°$ (*refracting edge vertical*), all that is necessary is to put $h=H$, $-h'=H'$, $D'=\zeta$, $A=A'$ in III (in the same way that formulae A were derived from I). Likewise, when $\psi=90°$ (*refracting edge horizontal*), we may similarly modify formulae B in accordance with III by using III−8 in place of $B-3$ to obtain r'_1, putting h' (given by III−6) for h in B−6 and B−7, replacing B−9 by III−10 and B−11 by III−11 to obtain D and A, and appropriately modifying B−8 and B−12 to

$$(8^*)\quad \zeta=\begin{cases}\theta+\omega & D'+\delta<90°\\ (180°-\theta)+\omega), & D'+\delta>90°\end{cases}$$

(B*)

$$(12^*)\quad A'=\begin{cases}ZSP'-\mathrm{A} & \\ A-ZSP' & D' \text{ upward}\\ 360°-(A+ZSP'), & D' \text{ downward}\end{cases}\quad \begin{matrix}D'+\delta>90°\\ D'+\delta<90°\end{matrix}$$

as shown by figure 18; the resulting collection of formulae,

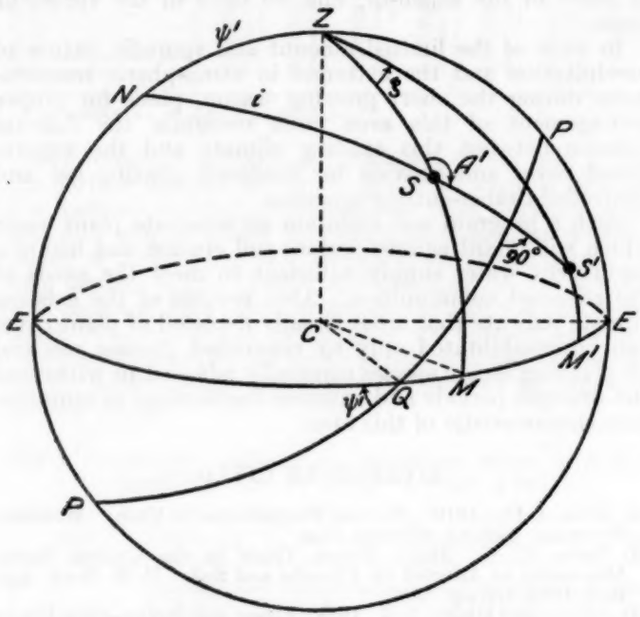


FIGURE 17. *Calculation of the image produced by simple reflection.* See formulae *D*. *Z*, zenith; *EME*, horizon; *S*, luminary, at altitude *H*; *PQP*, reflecting plane; *N*, pole of reflecting plane; *S'*, image; $SS'=D$, deviation; *A'*, position angle; ζ, azimuth; $S'M'=H'$, altitude of image. *S'* away from *N*.

FORMULAE D

CALCULATION OF THE IMAGE PRODUCED BY SIMPLE REFLECTION

Parameters: H; ψ', $0°\leq\psi'\leq180°$ $\psi'<90°$ when normal is directed upward; $\psi'>90°$ when directed downward.
Argument: i, $|\,90°-(H+\psi')\,|\leq i\leq90°$.
Calculation of D, A'; H', ζ:

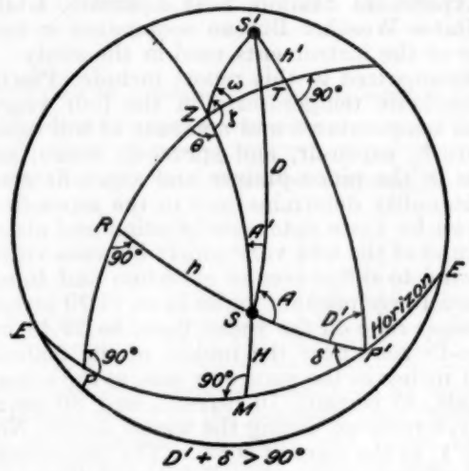
(1) $D=180°-2i$ away from N

(2) $$\cos A'=\frac{\sin\frac{D}{2}\sin H-\cos\psi'}{\cos\frac{D}{2}\cos H}$$

(3) $\sin H'=\cos D\sin H+\sin D\cos H\cos A'$

(4) $$\sin\zeta=\frac{\sin D\sin A'}{\cos H'}$$

[See fig. 17. In the triangle *NZS*, the Law of Cosines gives $\cos\psi'=\cos i\sin H+\sin i\cos H\cos ZSN$; whence, solving for $\cos ZSN$, and using $A'=180°-ZSN$ and (1), we obtain (2). Formulae (3) and (4) follow from the Law of Cosines and the Law of Sines, respectively, in triangle *ZSS'*. For given H and ψ', minimum value of i occurs when *N* happens to lie on the solar vertical.]



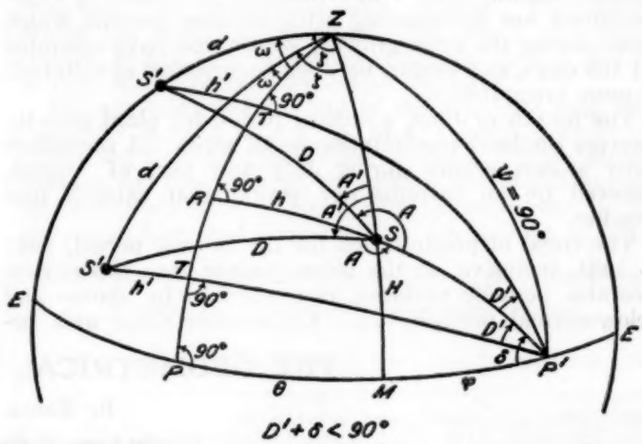


FIGURE 18. *Calculation of image produced by refraction combined with internal reflection when refracting edge is horizontal* (formulae *E*). *Z*, zenith; *EME*, horizon; *S*, luminary; *S'* image, *ZRP*, principal plane; *D*, deviation; *A'*, position angle; *d*, zenith distance; ζ, azimuth.

which may readily be written out explicitly when needed, will be referred to as **Formulae E.**

When the *reflection occurs from a principal plane*, formulae I* replace III in the foregoing discussion: With the *refracting edge in any position*, use formulae *C* except that D' is found from I−5 and the angles D and A from I*. With *refracting edge vertical*, put $h=H$, $D'=\zeta$, $A=A'$, $H'=-h$ in I*. With *refracting edge horizontal*, replace $B-9$ by I*−6* and $B-11$ by I*−7* to obtain D and A, and modify $B-8$ and $B-12$ in the same way as above; the resulting formulae will be referred to as **Formulae F.**

The systematic application of formulae A to F, inclusive, to the crystal angles and faces of given forms of ice crystals, in all orientations and at various altitudes of the luminary, will give the loci of the images that can be produced by refraction and reflection. The results obtained will be presented in succeeding papers.

TROPICAL DISTURBANCES ON THE NORTH ATLANTIC OCEAN, AUGUST 1937

By WILLIS E. HURD

[Weather Bureau, Washington, D. C., September 1937]

Two tropical disturbances originated on the North Atlantic in August 1937. Like the first tropical cyclone of the 1937 season, that of July 29–August 2, an account of which was published in the July issue of the REVIEW, neither of these was of hurricane intensity so far as present ships' reports indicate. The first of these disturbances showed signs of forming on the day that the July–August cyclone disappeared over the St. Lawrence Valley.

Cyclone of August 2–8, 1937.—At the 8 p. m. (E. S. T.) observation of August 2 evidence pointed to the existence of a slightly disturbed condition central near 24° N., 76° W. There was squally weather in the locality of the northern Bahamas on the morning of the 3d, accompanied by a weak cyclonic circulation, and a slight depression of the barometer central east-northeast of Nassau. By 8 p. m. (E. S. T.) of the 3d the circulation had strengthened and the depression had enlarged, with northward movement. The center was then near 26½° N., 76½° W.

During the 4th the slow northward movement of the LOW continued, with the center approximately 250 miles off the northeast Florida coast. Its intensity increased only slightly during the day, but the winds, though generally light, continued squally, with local winds of force 6, the highest reported.

On the morning of the 5th the LOW with center 175 miles east of the South Carolina coast, had contracted somewhat in size, but with little or no increase in general intensity. In the afternoon, however, the American steamer *Andrea F. Luckenbach*, northbound near 34½° N., 74° W., encountered an east gale of force 8. The ship's lowest barometer, at 8 p. m., was only 29.81. The cyclonic center at that time was near 33° N., 75½° W.

During the 6th the disturbance, although continuing to be shallow, increased in wind energy, and at 2:30 a. m.—exact location within the disturbed area unknown—the American steamer *Bienville* experienced a southeast gale of force 10. The storm was centered at 8 a. m. (E. S. T.) of the 6th approximately 100 miles east of Hatteras, moving northeastward. At 8 p. m. it had reached a point about 200 miles east of the Virginia Capes, covering a small area as a closed circulation, but strengthening the winds for a considerable distance in the direction of the high-pressure area adjoining it to the eastward. At the evening observation the American ketch *Atlantis*, near 37½° N., 71° W., reported a southeast gale of force 9, increasing at 9:30 p. m. (local) to force 10.

On the morning of the 7th the center lay southeast of Nantucket, with no winds higher than force 7 reported at the regular observing hour. A special report from the Norwegian steamer *Harboe Jensen*, at 11 a. m., gave a southeast gale of force 10, barometer 29.71, at 40°12′ N., 67°54′ W. Shortly thereafter the wind on ship diminished and shifted to west-northwest. The lowest reported barometer in connection with this disturbance was 29.67, read on the American steamer *American Trader*, wind south-southwest, force 9, at 11:30 p. m. of the 7th, at 41°10′ N., 65°50′ W.

During the 8th the disturbance lost energy while passing to the east-northeastward south of Nova Scotia and had practically dissipated near Sable Island before the regular morning observation of the 9th. Its entire course was spent at sea.

As early as the 3d, the Weather Bureau forecast center at Jacksonville, Fla., issued an advisory warning of the disturbance, and further advisories regarding its energy, location, and movement, were issued up to 9:30 a. m. of the 4th. At 10 p. m. of the 5th, when the cyclone was nearly due south of Hatteras, northwest storm warnings were ordered from Washington for the coast between Cape Hatteras and the Virginia Capes, and caution advised for small vessels in the vicinity.

Cyclone of August 24–September 2, 1937.—In a report received on August 23 at the forecast center at San Juan, P. R., from Fort-de-France, Martinique, transmittal was made of a ship report indicating a disturbed area south of 18° N., in longitude 51° W. On the strength of this information, San Juan issued an advisory warning for the benefit of vessels east of the Leeward Islands. At 11 p. m. of this date the Dutch S. S. *Baarn* had an east-northeast wind of force 7, barometer 30.06, in 19°48′ N., 58°36′ W. This wind appeared to denote an intensified trade, but Lesser Antillean land reports indicated a mildly disturbed area east of the Leeward Islands.

On the 24th a depressed area, not yet established as an inclosed LOW, appeared northeast of the Leeward Islands in the morning and north of them at the evening observation, thus indicating it to have a west-northwest bearing.

During the 25th and 26th the disturbed condition, still showing immature circulation and lack of strong winds, continued to advance toward the west-northwest, and by 8 p. m. of the 26th was north of Turks Island. At 8 p. m. of the 27th it was over the eastern Bahamas, attended by winds no stronger than light to moderate squalls. During the 28th the weather continued squally as on the preceding day, though the disturbed area had widened over a region central near, but slightly north of Nassau, and with little evidence of cyclonic circulation to be observed. At a distance of nearly 200 miles to the eastward of the center, near 25½° N., 74° W., the American steamer *C. A. Canfield* reported a south-southeast wind of force 7, barometer 29.88, at 4 p. m., and near that time a maximum force of 8 from the south. Slightly to the northward, at 7 p. m., the American steamer *Colombia* reported a southeast gale, also of force 8.

On the 29th the disturbance, moving northwestward, was central at 8 p. m. off the middle east coast of Florida attended by increasingly squally weather and a slight fall in barometer. The American motorship *Matagalpa*, in 28°30′ N., 78°40′ W., reported an east-southeast gale of force 9, barometer 29.69, during a squall that was apparently of short duration. At about 10 p. m. a southeast gale of force 10—the heaviest reported by a ship in connection with the disturbance—was encountered by the American steamer *Solana*, barometer 29.75, in 28°36′ N., 78°38′ W. This ship, southbound, had heavy weather with strong to whole gales from 5 p. m. of the 29th until 2.30 a. m. of the 30th, after which the weather rapidly moderated.

At 7.30 a. m. (E. S. T.) of August 30 the center of the disturbance then turning more toward the west was near the extreme northeastern Florida coast. At that time,

near 29° to 30° N., 78° to 80° W., ships were reporting southeast winds of force 6 to 8. The highest wind reported by a vessel in east coast waters during the morning was of force 9 from the southeast, at 4.30 a. m., in 30° N., 80°15′ W., barometer 29.79.

The following description of the history of the storm as it affected the coast and mainland of Florida, is quoted from the report of Mr. Grady Norton, forecaster on duty at Jacksonville:

> The center of the storm passed inland on the east Florida coast moving in a northwesterly direction about 9 a. m. to 10 a. m. on August 30 in the vicinity of Ormond Beach, attended by gales of 50 to 60 miles per hour over a stretch of the coast extending roughly from New Smyrna to St. Augustine. The lowest pressure reported was 29.38 inches, by the Coast Guard at the northern end of Daytona Beach, though this location was probably not in the exact center and may not represent the lowest experienced.
>
> No lives were lost on this stretch of coast, but considerable minor property damage occurred to communication lines and electric wires, and also to some buildings and other flimsy structures. A good many trees were blown down on wires and across highways, causing temporary delays in traffic.
>
> Timely and accurate warnings doubtless resulted in considerable saving of property throughout the affected area. Small craft had been secured in safe places and low islands evacuated well in advance of the storm.
>
> This storm was very small in diameter but rather intense for its size, and was remarkably persistent after passing inland. Although it gradually lost intensity, it caused some damage to power lines at Lake City, Fla., more than 100 miles from where it entered land from the Atlantic, and heavy rains and squalls persisted on through the northwestern counties of Florida causing considerable damage by flooding and washing out of roads and bridges. A maximum wind velocity of 28 miles per hour was reported from Apalachicola just after the passage of the center some distance to the north of that place.
>
> The S. S. *Tarpon* sank off Panama City, Fla., with loss of possibly 15 lives. Press reports indicate that heavy squalls attending the disturbance may have been the cause, but this had not been definitely established. * * * The disturbance preserved its identity on northwestward through Alabama, Mississippi, and Arkansas.

As the storm went inland, exceptionally high tides were reported northward along the upper Florida and the Georgia coasts. In Alabama, on September 1, heavy rains over the southern part of the State caused damage to crop and other property estimated in press reports as amounting to possibly millions of dollars.

The disturbance was well covered by advisories issued at San Juan on August 23 to 25, and later by those issued at Jacksonville. Northeast storm warnings were ordered at 7.30 p. m. (E. S. T.) of the 29th northward from Vero Beach to St. Augustine, Fla., and at 3 a. m. of the 30th, from St. Augustine to Savannah.

NOTES AND REVIEWS

B. HAURWITZ. *The Physical State of the Upper Atmosphere.* Rep. from *Jour. Roy. Astron. Soc. Can.*, 1936 Oct.–1937 Feb. University of Toronto Press, 1937.

H. R. MIMNO. *The Physics of the Ionosphere. Reviews of Modern Physics*, vol. 9, pp. 1–43, 1937 Jan.

The phenomena and physical conditions in the extreme upper atmosphere have in recent years come to be of increasing interest to meteorologists; and at the present time, active investigations are in progress to determine the possible influence of some of these phenomena on meteorological conditions in the lower atmosphere. The literature of the subject is extensive and rapidly growing.

The series of articles by Haurwitz is a general summary of present knowledge of the outer atmosphere, with 121 bibliographic references. Among the topics discussed are optical phenomena of the high atmosphere, nacreous and noctilucent clouds, meteor phenomena, the light from the night sky, ionization in the upper atmosphere and its role in the propagation of electromagnetic waves and in the diurnal variations of terrestrial magnetism, the aurora, atmospheric ozone, anomalous propagation of sound in the atmosphere, and the chemical composition of the air at high levels.

The paper by Mimno is a technical discussion of observational facts and physical theories relating to the propagation of radio waves and the state of the ionized regions, and their relations to other geophysical phenomena, with over 300 references to the literature.—*Edgar W. Woolard.*

BIBLIOGRAPHY

[RICHMOND T. ZOCH, in charge of Library]

By AMY D. PUTNAM

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Ackeret, J.

High-speed wind tunnels. Washington. November 1936. 22 p. figs., diagrs. 26½ cm. (U. S. National advisory committee for aeronautics. Technical memorandum. No. 808.)

The blizzard men of 1888. An account of the annual meeting and luncheon of March 12, 1936, New York City, and some historical references. Newark, N. J. 1937. [12] p. 23 cm.

Ertel, Hans.

Zusammenhang von Luftdruckänderungen und Singularitäten des Impulsdichtefeldes. Berlin. 1936. 12 p. figs. 26 cm. [Sonderausgabe aus den Sitzungsberichten der Preuss. Akademie der Wissenschaften, Phys.-Math. Klasse, 1936. XX.]

Great Britain. Meteorological office.

Averages of bright sunshine for the British Isles for periods ending 1935. London. 1936. 43 p. tables. 24½ cm. (M. O. 408.)

Hannay, Mrs. Annie Murray, comp.

The influence of weather on crops; 1900–1930; a selected and annotated bibliography. Wash., D. C. 1931. 246 p. 23½ cm. (U. S. Dept. of agric. Miscell. pubn. no. 118.) Contribution from Bureau of agricultural economics.

Hoover, William H.

The dependence of carbon dioxide assimilation in a higher plant on wave length of radiation. Wash., D. C. 1937. 13 p. pls., diagrs. 24½ cm. (Smithsonian miscellaneous collections. v. 95, no. 21.) Publication 3406.

International commission for synoptic weather information.

Report of the tenth meeting, Warsaw, Sept. 5, 6, & 10, 1935, and of the joint meetings with the Climatology commission at Warsaw, Sept. 6 and 10, 1935. Leyde. 1936. 144 p. figs., tables. 24½ cm. (no. 31.)

International meteorological organization.

Conférence des directeurs à Varsovie 6–13 septembre 1935. Tome II. Appendices aux Procès-verbaux. Leyde. 1937. 215 p. illus., fold. map, tables (part fold.) 24 cm. (no. 29.)

——— **Secretariat.**

1. Comptabilité de l'année financière 1935–1936. II. Rapport sur les travaux du Secrétariat pendant l'année 1935–1936. [DeBilt.] 1936. 13 p. tables. 24½ cm.

Palmén, E.

Registrierballonaufstiege in einer tiefen Zyklone. Helsingfors. 1935. 32 p. figs., tables, diagrs. 24 cm. (Mitteilungen des Meteorologischen Instituts der Universität. Helsingfors. No: 26.)

Pardé, Maurice.

Les cours d'eau les mieux alimentés du monde. Pithiviers. [n. d.] 14 p. 24½ cm.

Recherches sur les gros débits des cours d'eau. Pithiviers. [n. d.] 15 p. 24½ cm.

Rôle de la neige dans le régime du Drac au Sautet. Pithiviers. [n. d.] 14 p. 25 cm.

Philp, Charles G.

The conquest of the stratosphere. London. 1937. ix, 205 p. illus. (map, chart). 19 cm.

Simpson, George, & Scrase, F. J.

The distribution of electricity in thunderclouds. Lond. 1937. p. 309–352. figs., plates, tables, diagrs. 25½ cm. [Reprinted from "Proceedings of the Royal Society of London", Series A. No. 906, vol. 161, p. 309–352, August 1937.]

Thornthwaite, C. Warren.

The life history of rainstorms. New York. 1937. p. 92–111. fold. map, figs., tabs., diagrs. 25½ cm. (Reprinted from Geographical review, v. XXVII, no. 1, Jan., 1937.)

Walters, Rupert Cavendish Skyring.

The nation's water supply. Lond. 1936. xv, 244 p. plates (part col.), maps (part fold.), diagrs. 23½ cm.

SOLAR OBSERVATIONS

SOLAR RADIATION OBSERVATIONS DURING AUGUST 1937

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged below normal for August at Washington and Madison, and close to normal at Lincoln.

Table 2 shows an excess in the amount of total solar and sky radiation received on a horizontal surface at all stations with the exception of Washington, Miami, New Orleans, Blue Hill and Friday Harbor—all enumerated stations being comparatively close to the Coasts.

Polarization measurements made at Madison on 9 days give a mean of 52 percent with a maximum of 62 percent on the 4th. Both of these values are slightly below the corresponding August normals.

TABLE 1.—*Solar radiation intensities during August 1937*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.				[1] 1.0	P. M.				
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Aug. 2	16.79	------	0.36	0.42	0.62	------	------	------	------	------	13.13
Aug. 3	15.65	------	------	.83	.97	1.26	------	------	------	------	14.10
Aug. 4	16.20	0.42	.51	.59	.86	------	------	------	------	------	14.10
Aug. 5	18.59	------	------	------	.76	------	------	------	------	------	17.37
Aug. 16	14.60	------	.76	.91	1.12	------	------	------	------	------	11.81
Aug. 17	14.10	------	------	.71	.95	------	------	------	------	------	14.60
Aug. 19	19.89	------	.42	.60	.86	------	------	------	------	------	19.89
Aug. 20	18.59	------	------	.56	.78	1.23	------	------	------	------	19.89
Aug. 21	19.89	------	------	------	.87	------	------	------	------	------	20.57
Means	------	(.42)	.51	.66	.87	1.24	------	------	------	------	------
Departures	------	−.21	−.17	−.10	−.07	−.01	------	------	------	------	------

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during August 1937*—Contd.

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.				1.0	P. M.				
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Aug. 4	14.60	------	------	1.04	1.22	1.42	------	------	------	------	17.96
Aug. 5	10.21	------	------	.97	1.13	1.36	------	------	------	------	9.47
Aug. 6	13.13	------	------	------	------	1.34	------	------	------	------	10.97
Aug. 7	14.10	------	.68	.80	1.08	------	------	------	------	------	13.13
Aug. 9	16.79	------	------	------	.98	1.32	------	------	------	------	17.37
Aug. 12	10.21	------	------	------	------	------	1.08	------	------	------	15.65
Aug. 13	11.38	------	------	.96	1.12	1.28	------	------	------	------	12.24
Aug. 14	11.81	------	------	.82	1.00	1.30	------	------	------	------	12.24
Aug. 23	11.38	------	------	.67	------	1.30	------	------	------	------	10.97
Aug. 24	12.68	------	------	------	------	1.34	------	------	------	------	13.13
Aug. 25	13.13	------	------	.70	.85	------	------	------	------	------	13.13
Aug. 27	16.20	------	.67	.86	------	------	------	------	------	------	15.65
Aug. 30	15.11	------	.56	.65	.88	------	------	------	------	------	14.10
Means	------	------	.64	.83	1.03	1.33	(1.08)	------	------	------	------
Departures	------	------	−.16	−.10	−.06	+0.01	+0.03	------	------	------	------

LINCOLN, NEBR.

Aug. 4	18.59	.64	.73	.86	1.10	1.38	------	------	------	------	16.20
Aug. 5	16.79	.65	.76	.93	1.10	------	------	------	------	------	11.81
Aug. 6	12.68	.60	.69	.86	1.06	1.40	------	------	------	------	13.13
Aug. 9	19.89	.58	.72	.86	1.08	1.37	------	------	------	------	19.23
Aug. 12	11.81	.80	.87	.95	1.24	1.47	------	------	------	------	9.83
Aug. 14	11.81	.72	.84	1.00	1.19	1.40	------	------	------	------	14.10
Aug. 16	15.65	.68	.80	.95	1.16	1.38	------	------	------	------	13.13
Aug. 20	16.79	------	------	------	------	------	1.17	0.99	0.79	0.68	13.61
Aug. 21	11.38	.84	.93	1.07	1.27	1.46	------	------	------	------	10.59
Aug. 27	15.65	------	.76	.91	1.16	1.43	------	------	------	------	15.11
Aug. 28	15.65	.63	.76	.89	1.12	1.35	------	------	------	------	12.24
Aug. 31	12.68	------	.72	.88	1.15	1.34	------	------	------	------	11.38
Means	------	.68	.78	.93	1.15	1.40	(1.17)	(0.99)	(0.79)	(0.68)	------
Departures	------	.00	.00	+.02	+.06	+.08	+0.10	+0.10	+0.04	+0.03	------

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca	Newport
	Gram-calories per square centimeter																
1937	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
July 30	504	557	592	526	516	706	337	599	544	460	448	562	474	500	613	512	525
Aug. 6	402	489	597	423	329	690	291	571	480	448	412	578	441	594	384	286	459
Aug. 13	522	503	565	508	464	650	269	556	416	440	343	540	511	551	574	490	479
Aug. 20	215	479	571	453	217	652	259	547	486	411	296	528	511	546	385	270	265
Aug. 27	398	489	550	426	332	640	219	465	543	422	376	482	409	575	486	290	375
	Departures from weekly normals																
July 30	+30	+88	+73	+138	+86	+62	+2	+53	.....	−19	−25	+25	−24	.....	+71	+60	.....
Aug. 6	−37	+31	+95	+30	−43	+71	−22	+24	.....	−60	−41	+33	−61	.....	−149	−140	.....
Aug. 13	+83	+60	+71	+111	+94	+49	−17	+66	.....	−22	−59	−6	+4	.....	+37	+56	.....
Aug. 20	−194	+37	+83	+50	−103	+58	−35	+18	.....	−71	−107	+10	+17	.....	−108	−136	.....
Aug. 27	−19	+83	+102	+69	−17	+62	−64	−24	.....	−54	−58	−8	−28	.....	+36	−67	.....
	Accumulated departures on Sept. 2																
	−2,520	+5,943	+3,682	+3,814	+4,943	+5,887	+637	+1,050	.....	−7,826	+4,641	−3,388	−1,330	.....	−651	−4431	.....

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Mount Wilson group number	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	*h. m.*		°	°	°				
Aug. 1	11 18	5492	−75.0	229.2	−19.0	97	.....	.....	U. S. Naval.
		5491	−71.0	233.2	−30.0	.....	242	.....	
		5489	−53.0	251.2	+24.0	.....	1018	.....	
		5488	−52.0	252.2	+31.0	.....	242	.....	
		5486	−29.0	275.2	−13.0	.....	97	.....	
		5487	−26.0	278.2	+14.0	.....	24	.....	
		5490	−26.0	278.2	+17.0	.....	24	.....	
		5484	−11.0	293.2	+9.0	24	.....	.....	
		5483	−11.0	293.2	−11.0	.....	291	.....	
		5481	−9.0	295.2	+30.0	170	.....	.....	
		5485	+1.0	305.2	−21.0	.....	73	.....	
		5477	+41.0	345.2	+33.0	.....	1212	.....	
		5477	+60.0	4.2	+29.5	.....	1309	4,823	
Aug. 2	11 11	5492	−61.0	230.1	−19.0	97	.....	.....	Do.
		5491	−59.0	232.1	−30.0	.....	194	.....	
		5489	−41.0	250.1	+24.0	.....	873	.....	
		5488	−40.5	250.6	+31.0	.....	267	.....	
		5486	−16.0	275.1	−12.0	.....	73	.....	
		5490	−14.0	277.1	+18.0	.....	97	.....	
		5484	+1.0	292.1	+9.0	24	.....	.....	
		5483	+2.0	293.1	−11.0	.....	194	.....	
		5481	+5.0	296.1	+30.0	145	.....	.....	
		5485	+14.0	305.1	−21.5	.....	97	.....	
		5477	+54.5	345.6	+33.0	.....	1115	.....	
		5477	+74.0	5.1	+29.5	.....	1212	4,388	
Aug. 3	11 10	5492	−49.0	228.8	−19.0	73	.....	.....	Do.
		5491	−47.0	230.8	−30.0	.....	97	.....	
		5489	−28.0	249.8	+23.0	.....	873	.....	
		5488	−27.5	250.3	+31.0	.....	267	.....	
		5486	−2.0	275.8	−12.0	.....	73	.....	
		5490	−2.0	275.8	+19.0	.....	97	.....	
		5487	−1.0	276.8	+12.5	.....	48	.....	
		5484	+15.0	292.8	+9.0	24	.....	.....	
		5483	+15.0	292.8	−11.0	.....	194	.....	
		5481	+18.5	296.3	+30.0	145	.....	.....	
		5485	+30.0	307.8	−20.0	16	.....	.....	
		5477	+67.0	344.8	+33.0	.....	921	.....	
		5493	+70.0	347.8	+15.0	.....	97	.....	
		5477	+83.0	0.8	+30.0	873	.....	3,798	
Aug. 4	10 40	5499	−74.0	190.9	−9.0	24	.....	.....	Do.
		5497	−73.0	191.9	−11.0	436	.....	.....	
		5492	−36.0	228.9	−19.0	73	.....	.....	
		5491	−35.0	229.9	−30.0	.....	73	.....	
		5489	−15.0	249.9	+23.0	.....	727	.....	
		5488	−14.0	250.9	+30.0	.....	242	.....	
		5495	−3.5	261.4	−14.0	16	.....	.....	
		5486	+11.0	275.9	−12.0	.....	97	.....	
		5487	+11.0	275.9	+12.5	.....	48	.....	
		5490	+12.0	276.9	+18.0	.....	48	.....	
		5483	+28.0	292.9	−11.0	.....	194	.....	
		5484	+28.5	293.4	+9.0	16	.....	.....	
		5481	+30.0	294.9	+30.0	.....	73	.....	
		5485	+42.0	306.9	−20.0	16	.....	.....	
		5493	+80.0	344.9	+17.0	97	.....	.....	
		5477	+80.0	344.9	+33.0	.....	776	2,956	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group number	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	*h. m.*		°	°	°				
Aug. 5	11 14	5499	−60.0	191.4	−9.0	24	.....	.....	U. S. Naval.
		5497	−59.0	192.4	−11.0	436	.....	.....	
		5492	−22.0	229.4	−19.0	.....	73	.....	
		5491	−19.0	232.4	−29.0	.....	73	.....	
		5489	−2.0	249.4	+23.0	.....	582	.....	
		5488	−1.0	250.4	+30.0	.....	242	.....	
		5495	+11.0	262.4	−14.0	.....	73	.....	
		5486	+24.0	275.4	−13.0	.....	48	.....	
		5487	+25.0	276.4	+13.0	.....	97	.....	
		5484	+41.0	292.4	+9.0	24	.....	.....	
		5483	+43.0	294.4	−11.0	.....	121	.....	
		5481	+44.0	295.4	+29.5	12	.....	.....	
		5485	+56.0	307.4	−20.0	24	.....	1,829	
Aug. 6	10 46	5497	−46.0	192.4	−11.5	436	.....	.....	Do.
		5499	−45.0	193.4	−9.0	.....	24	.....	
		5492	−9.5	228.9	−19.5	48	.....	.....	
		5491	−5.0	233.4	−28.0	.....	48	.....	
		5489	+10.0	248.4	+24.0	.....	485	.....	
		5488	+11.5	249.9	+30.0	242	.....	.....	
		5495	+24.0	262.4	−14.0	.....	194	.....	
		5486	+37.0	275.4	−13.0	.....	24	.....	
		5487	+39.0	277.4	+12.0	.....	48	.....	
		5483	+58.0	296.4	−11.0	.....	97	1,646	
Aug. 7	10 51	5500	−59.0	166.1	−13.0	.....	24	.....	Do.
		5497	−32.0	193.1	−11.0	436	.....	.....	
		5499	−30.0	195.1	−9.5	.....	48	.....	
		5492	+3.5	228.6	−19.5	48	.....	.....	
		5491	+12.0	237.1	−28.0	.....	24	.....	
		5489	+21.0	246.1	+24.0	.....	485	.....	
		5488	+24.0	249.1	+31.0	242	.....	.....	
		5495	+38.0	263.1	−14.0	.....	291	.....	
		5486	+52.0	277.1	−12.0	12	.....	.....	
		5483	+71.0	296.1	−12.0	97	.....	1,707	
Aug. 8	8 43	5505	−83.0	130.1	+14.0	24	.....	.....	Mt. Wilson.
		5506	−78.0	135.1	+20.0	.....	97	.....	
		5507	−77.5	135.6	−22.0	.....	194	.....	
		5504	−65.0	148.1	+19.5	.....	24	.....	
		5503	−48.0	165.1	−23.0	.....	48	.....	
		5502	−26.0	187.1	−19.0	.....	73	.....	
		5497	−20.5	192.6	−11.0	.....	436	.....	
		5499	−18.0	195.1	−9.0	.....	121	.....	
		5501	−10.5	202.6	−20.5	.....	12	.....	
		5492	+16.0	229.1	−20.0	.....	36	.....	
		5491	+24.0	237.1	−28.0	.....	24	.....	
		5489	+34.0	247.1	+24.0	.....	194	.....	
		5488	+37.0	250.1	+31.0	242	.....	.....	
		5495	+50.5	263.6	−14.0	.....	388	.....	
		5483	+83.0	296.1	−13.0	97	.....	2,010	
Aug. 9	10 56	5505	−69.0	129.6	+13.0	.....	48	.....	U. S. Naval.
		5507	−67.0	131.6	−23.0	.....	582	.....	
		5506	−64.0	134.6	+18.5	.....	48	.....	
		5504	−48.5	150.1	+18.5	.....	24	.....	
		5503	−33.0	165.6	−25.0	.....	48	.....	
		5502	−9.0	189.6	−20.0	.....	24	.....	
		5497	−6.0	192.6	−13.0	.....	388	.....	
		5499	−2.0	196.6	−10.0	.....	97	.....	
		5501	+6.0	204.6	−21.0	.....	48	.....	
		5492	+30.0	228.6	−20.0	12	.....	.....	
		5509	+35.0	233.6	−35.0	.....	24	.....	
		5491	+39.0	237.6	−28.0	.....	48	.....	
		5489	+49.0	247.6	+22.0	.....	121	.....	
		5488	+50.0	248.6	+30.0	242	.....	.....	
		5508	+65.0	263.6	+14.0	16	.....	.....	
		5495	+65.0	263.6	−13.0	.....	388	2,158	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group number	Heliographic			Area		Total area for each day	Observatory
			Diff. in longitude	Longitude	Latitude	Spot	Group		
1937	h. m.		°	°	°				
Aug. 10	12 5	5512	−81.0	103.8	+10.0	145			U. S. Naval.
		5511	−56.0	128.8	−15.0	36			
		5507	−54.0	130.8	−23.0	533			
		5505	−53.0	131.8	+12.5		97		
		5506	−50.5	134.3	+18.5		24		
		5503	−18.5	166.3	−25.0		24		
		5502	+3.5	188.3	−20.0		24		
		5497	+8.5	193.3	−13.0		388		
		5499	+10.5	195.3	−10.0		97		
		5510	+11.0	195.8	+17.0	12			
		5501	+19.0	203.8	−21.0		73		
		5491	+51.0	235.8	−28.5		48		
		5489	+62.0	246.8	+22.0		73		
		5488	+63.0	247.8	+30.0	242			
		5495	+78.0	262.8	−14.0		194		
		5508	+80.0	264.8	+14.0	97		2,107	
Aug. 11	10 58	5512	−69.0	103.2	+9.5	48			Do.
		5511	−46.0	126.2	−16.0		36		
		5507	−42.0	130.2	−23.5		533		
		5505	−37.0	135.2	+12.0		242		
		5502	+13.5	185.7	−19.0		12		
		5497	+20.5	192.7	−13.0	388			
		5499	+23.0	195.2	−8.0	145			
		5501	+32.0	204.2	−20.5	48			
		5491	+63.0	235.2	−27.0		73		
		5489	+74.5	246.7	+22.0		12		
		5488	+76.0	248.2	+30.0	242		1,779	
Aug. 12	11 1	5512	−56.0	102.9	+9.5	61			Do.
		5507	−30.0	128.9	−23.0		533		
		5505	−24.0	134.9	+12.0		291		
		5515	+21.0	179.9	−10.5		121		
		5514	+25.0	183.9	+15.0	24			
		5497	+34.0	192.9	−13.0	436			
		5499	+37.0	195.9	−8.0		145		
		5513	+49.0	207.9	−7.0		48		
		5488	+88.0	246.9	+31.0	97		1,756	
Aug. 13	11 35	5512	−43.0	102.4	+10.0		97		Do.
		5507	−17.0	128.4	−23.0		533		
		5505	−9.0	136.4	+11.0		388		
		5515	+34.0	179.4	−11.0		121		
		5497	+47.0	192.4	−13.0		388		
		5499	+50.0	195.4	−8.0		97	1,624	
Aug. 14	11 10	5512	−30.0	102.4	+10.0		97		Do.
		5507	−4.0	128.4	−23.0		533		
		5511	−2.0	130.4	−15.0	24			
		5505	+4.0	136.4	+11.0		727		
		5516	+17.0	149.4	+17.5		48		
		5515	+48.0	180.4	−11.0		97		
		5497	+61.0	193.4	−13.0		388	1,914	
Aug. 15	11 18	5512	−17.5	101.6	+10.0		97		Do.
		5511	+10.0	129.1	−15.0		24		
		5507	+11.0	130.1	−23.0		485		
		5505	+18.0	137.1	+11.0		921		
		5516	+32.0	151.1	+18.0		36		
		5515	+61.0	180.1	−12.0		73		
		5497	+74.0	193.1	−13.0	388		2,024	
Aug. 16	12 7	5512	−4.0	101.5	+10.5		97		Do.
		5507	+24.0	129.5	−23.0		436		
		5505	+31.0	136.5	+11.0		921		
		5516	+48.0	153.5	+17.5		24		
		5519	+59.0	164.5	−16.5	24			
		5515	+85.0	190.5	−12.0	48		1,550	
Aug. 17	11 1	5520	−88.0	4.8	+30.0	194			Do.
		5521	−88.0	4.8	+23.0	48			
		5512	+9.0	101.8	+10.5		97		
		5507	+36.0	128.8	−23.0		388		
		5505	+45.0	137.8	+11.0		824		
		5519	+79.0	171.8	−16.5	12		1,563	
Aug. 18	12 5	5522	−88.0	351.0	+32.5		727		Do.
		5520	−73.0	6.0	+29.5	194			
		5521	−73.0	6.0	+23.0	24			
		5512	+20.0	99.0	+10.5		97		
		5507	+50.0	129.0	−24.0		291		
		5505	+53.0	132.0	+11.0		436		
		5505	+66.0	145.0	+10.0		339	2,108	
Aug. 19	13 2	5525	−80.0	345.3	−16.5	12			Do.
		5522	−73.0	352.3	+32.5	970			
		5524	−65.0	0.3	−11.0		121		
		5520	−59.0	6.3	+30.0	97			
		5521	−58.0	7.3	+23.5	73			
		5523	−53.0	12.3	−28.0		121		
		5512	+34.0	99.3	+11.0		97		
		5507	+68.0	133.3	−25.0		291		
		5505	+69.0	134.3	+11.0		436		
		5505	+81.0	146.3	+10.5	291		2,509	
Aug. 20	9 1	5525	−68.0	346.3	−17.0		36		Mt. Wilson.
		5522	−64.0	350.3	+33.0	1,115			
		5521	−52.0	2.3	+23.0	36			
		5520	−49.0	5.3	+31.0		73		
		5524	−49.0	5.3	−9.5		242		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group number	Heliographic			Area		Total area for each day	Observatory
			Diff. in longitude	Longitude	Latitude	Spot	Group		
1937	h. m.		°	°	°				
		5523	−41.0	13.3	−27.5		194		Mt. Wilson.
		5526	+19.0	73.3	−28.0	6			
		5512	+48.5	102.8	+11.0		48		
		5505	+83.0	137.3	+11.0		436		
		5507	+85.0	139.3	−26.0		291	2,477	
Aug. 21	10 59	5527	−80.0	320.0	+13.5	48			U. S. Naval.
		5525	−53.0	347.0	−18.0		36		
		5522	−49.0	351.0	+33.0	1,261			
		5524	−36.0	4.0	−9.5		242		
		5521	−35.0	5.0	+21.5	24			
		5520	−34.5	5.5	+30.0		16		
		5523	−27.0	13.0	−27.5		145		
		5512	+63.0	103.0	+10.0	24		1,796	
Aug. 22	13 26	5527	−65.0	320.4	+13.5	48			
		5530	−61.0	324.4	+30.0		36		Do.
		5522	−36.0	349.4	+32.0	1,261			
		5525	−33.0	352.4	−16.5		48		
		5520	−22.0	3.4	+31.0	16			
		5521	−21.5	3.9	+21.0	16			
		5524	−20.0	5.4	−10.0		194		
		5523	−13.0	12.4	−27.5		194		
		5528	+53.0	78.4	+18.0		97	1,910	
Aug. 23	9 13	5531	−59.5	315.0	−19.5		24		Mt. Wilson.
		5527	−54.0	320.5	+14.0	61			
		5533	−45.0	329.5	+15.0		121		
		5522	−25.5	349.0	+33.0		1,261		
		5525	−23.0	351.5	−15.0		194		
		5521	−7.0	7.5	+22.0		16		
		5524	−7.0	7.5	−9.5		36		
		5524	−3.0	11.5	−9.5		194		
		5523	−3.0	11.5	28.0		291		
		5532	+3.0	17.5	+21.0		12		
		5528	+64.0	78.5	+17.0		170	2,380	
Aug. 24	9 7	5529	−47.5	313.9	+17.0		48		Do.
		5527	−39.5	321.9	+15.0	61			
		5533	−31.0	330.4	+15.5		121		
		5522	−13.0	348.4	+33.0		1,115		
		5525	−8.0	353.4	−15.0		291		
		5524	+9.5	10.9	−9.5		242		
		5523	+11.0	12.4	−27.0		339		
		5535	+13.0	14.4	+10.0		36		
		5532	+16.0	17.4	+21.0		36		
		5534	+19.0	20.4	+16.0		48		
		5528	+76.0	77.4	+18.0		97		
		5528	+88.0	89.4	+15.0	97		2,531	
Aug. 25	9 26	5529	−33.0	315.0	+16.5		48		Do.
		5527	−26.0	322.0	+15.0	48			
		5533	−17.0	331.0	+15.0		73		
		5522	+1.0	349.0	+33.0		921		
		5525	+7.0	355.0	−14.0		315		
		5520	+16.5	4.5	+32.0		36		
		5521	+16.5	4.5	+23.0		48		
		5524	+22.5	10.5	−9.5		194		
		5523	+24.0	12.0	−27.0		339		
		5532	+29.0	17.0	+21.0		73		
		5534	+36.0	24.0	+15.5		36	2,131	
Aug. 26	1 19	5536	−81.0	281.1	−12.0		36		U. S. Naval.
		5529	−20.5	311.6	+15.5		24		
		5527	−10.5	321.6	+14.5	36			
		5533	+1.0	333.1	+13.0	16			
		5522	+14.5	346.6	+32.0		776		
		5525	+21.0	353.1	−15.0		291		
		5521	+30.0	2.1	+22.0		48		
		5524	+36.0	8.1	−10.5		170		
		5523	+37.5	9.6	−28.0		267		
		5532	+45.0	17.1	+19.5		24		
		5534	+50.5	22.6	+14.0		97	1,785	
Aug. 27	11 5	5539	−79.0	241.7	+10.5	121			Do.
		5538	−78.0	242.7	+29.5		291		
		5536	−39.5	281.2	−12.0	36			
		5529	−10.0	310.7	+15.0		24		
		5537	−1.0	319.7	+32.0		48		
		5527	+1.0	321.7	+15.0	36			
		5533	+12.0	332.7	+13.0		24		
		5522	+25.0	345.7	+33.0		824		
		5525	+30.0	350.7	−15.0		97		
		5525	+38.0	358.7	−12.0	194			
		5524	+48.0	8.7	−10.0		291		
		5523	+49.0	9.7	−28.0		145		
		5534	+63.0	23.7	+13.0		170	2,301	
Aug. 28	11 15	5539	−69.0	238.4	+12.0		121		Do.
		5538	−68.0	239.4	+29.0		291		
		5536	−25.0	282.4	−12.5		61		
		5537	+12.0	319.4	+31.0		24		
		5527	+15.0	322.4	+15.0	24			
		5533	+26.0	333.4	+13.0		24		
		5522	+38.5	345.9	+33.0		970		
		5525	+41.0	348.4	−16.0	24			
		5525	+51.0	358.4	−13.0		194		
		5523	+59.0	6.4	−29.0		97		
		5524	+62.0	9.4	−11.0	194			
		5534	+75.0	22.4	+13.0		339	2,363	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group number	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	*h. m.*		°	°	°				
Aug. 29	9 9	5539	−57.0	238.3	+12.0		170		Mt. Wilson.
		5538	−57.0	238.3	+28.0		485		
		5536	−11.0	284.3	−12.0		36		
		5537	+24.0	319.3	+32.0		48		
		5527	+27.0	322.3	+15.0		36		
		5533	+37.0	332.3	+12.0		6		
		5522	+50.0	345.3	+33.0		970		
		5525	+65.0	0.3	−13.0	194			
		5521	+70.0	5.3	+23.0		24		
		5523	+71.0	6.3	+30.5	16			
		5524	+78.0	13.3	−11.0	194			
		5534	+88.0	23.3	+14.0	242		2,421	
Aug. 30	9 9	5540	−88.0	194.1	+20.0	145			Do.
		5539	−44.0	238.1	+12.0		121		
		5538	−44.0	238.1	+29.0		582		
		5536	+3.0	285.1	−13.0		48		
		5533	+37.5	319.6	+13.0		73		
		5527	+40.0	322.1	+15.0	12			
		5522	+63.0	345.1	+33.0		291		
		5525	+79.0	1.1	−14.5		145	1,417	
Aug. 31	10 50	5543	−78.0	190.0	−13.0	12			U. S. Naval.
		5540	−75.0	193.0	+18.5		170		
		5542	−49.0	219.0	+6.0		48		
		5538	−31.0	237.0	+29.0		436		
		5539	−27.5	240.5	+11.5		48		
		5536	+19.5	287.5	−12.0		48		
		5541	+58.0	326.0	−12.5	6			
		5533	+63.0	331.0	+12.5		121		
		5522	+75.0	343.0	+33.0		582	1,471	

Mean daily area for 31 days, 2,233.

PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR AUGUST 1937

[Dependent alone on observations at Zurich and its station at Arosa]

[Furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

August 1937	Relative numbers	August 1937	Relative numbers	August 1937	Realtive numbers
1		11	140	21	80
2	*a* 180	12	*Mc* 144	22	103
3	*Mc* 207	13	114	23	*Eac* 139
4	*d* 197	14	*ab* 124	24	*Mca* 150
5	*ab* 205	15	128	25	*ab* 137
6	176	16	119	26	144
7	135	17		27	*d* 143
8	*d* 154	18	*dd* 82	28	130
9	173	19	*Ec* 88	29	110
10	*a* 183	20	*Ec* 96	30	*d* 109
				31	128

Mean, 29 days=138.6.

a=Passage of an average sized group through the central meridian.
b=Passage of a large group or spot through the central meridian.
c=New formation of a group developing into a middle sized or large center of activity; *E:* on the eastern part of the sun's disk, *W:* on the western part, *M:* in the central circle zone.
d=Entrance of a large or average sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. Little, in Charge]

By L. P. Harrison

Mean free-air data based on airplane weather observations during the month of August 1937 are given in tables 1 to 3. A description of the methods by which the various monthly means and normals therein are computed may be found in this section of the Monthly Weather Review for January and March 1937.

It will be noted that many of the "normals" are based on only 3 years of observations. Conclusions based on departures from such short-period "normals" must be used with caution.

The mean surface temperatures for August (see chart I) were above normal over practically the entire country. The largest positive departures at the surface were largely concentrated in the north-central part of the country, with values ranging from about +2° C. to +5.6° C. Elsewhere the positive departures generally averaged from +1° C. to +3° C. Slight negative departures occurred over small areas in the extreme northwest, the central California coast, northern Florida, and southeastern Georgia.

The mean free-air temperatures for the month up to 5 kilometers above sea level (table 1) were generally above normal, except over the extreme northwestern and the southeastern sectors of the country where they were largely below the normal by slight amounts. The greatest positive departures prevailed over the north-central portion in harmony with the conditions observed at the surface; however, the (available) values here ranged only from +1° C. to +3.7° C. in the free air. The northeast coastal area was characterized by similar departures with a slightly lower extreme. The departures of positive sign were elsewhere of inconsequential magnitude. It is of interest to note the pronounced horizontal gradient of temperature over the Western Plateau Region at 2 kilometers. This is best exemplified by the data for Salt Lake City and Cheyenne which had a monthly mean temperature of 22.7° C. and 17.9° C., respectively.

The mean free-air relative humidities and specific humidities are given in table 2. The distribution of the positive and negative departures of relative humidity from the normals in the eastern part of the country during this month was not very regular over extensive areas (i. e. spotted). Near the northeastern coastal region slight to moderate positive departures (2 to 13 percent) were prevalent. The middle-Atlantic coastal area had practically normal humidities up to 4 kilometers. The data in the table for Lakehurst, N. J., indicates a departure of −21 percent at 5 kilometers. This subnormal value, presumably resulting from fewness of observations, is open to some doubt especially since the data for Norfolk, Va., portrayed departures decreasing from +9 percent at the surface to +3 percent at 2 and 2.5 kilometers then increasing to +12 percent at 5 kilometers. The region immediately south of the Great Lakes was generally characterized by slight positive departures at low elevations and moderate negative departures at the high elevations (−10 to −14 percent at 5 kilometers). Elsewhere in the east slight to low moderate departures of either sign occurred over various localities. On the other hand, the western half of the country judging from available data largely had humidities which were below normal by slight to moderate extents, except in the extreme northwest. There, small positive departures prevailed. Humidity conditions in the Dakotas were apparently similar to those occurring in connection with the western regime of deficient values.

Table 3 shows the monthly mean free-air barometric pressures and equivalent potential temperatures. The

isobaric charts constructed on the basis of the former data disclosed very "flat" pressure conditions over the entire country on the average, with but slightly higher pressures in the East than the West and in the South than the North. At elevations from 3 to 5 kilometers an appreciable average pressure gradient existed from the central Western Plateau Region northwestward (e. g., 5 kilometers, mean sea level, Salt Lake City mean pressure 560 mb; Spokane, 554 mb). A high-level Plateau anti-cyclone of limited extent and slight intensity presumably was connected with this phenomenon and with the above-normal transport of air from the Southwest and West over the extreme Northwest sector as indicated by the resultant winds for the levels in question.

Table 4 shows the free-air resultant winds based on pilot-balloon observations made near 5 a. m. (75th meridian time) during August. Generally speaking, the resultant winds were practically normal in direction over the entire country with a few notable exceptions: Georgia, northern Florida, and Washington, as exemplified by Atlanta, Pensacola, and Seattle, respectively. Over the former two stations, the resultants for the month were oriented at various levels, excluding the surface stratum, perhaps 30° to about 110° counterclockwise from the corresponding normals, i. e., from a more southwesterly or southerly direction. Over the latter station at elevation 0.5 to 1 kilometer, the resultants were oriented from 80° to 160° clockwise from normal, while at elevations 1.5 to 2 kilometers, they were oriented 120° to 25° counterclockwise, i. e., from more southerly directions.

The resultant velocities were largely below normal in the eastern half of the country and above normal in the western half. The departures in this respect were mostly slight, i. e., less than 3 meters per second. Positive departures in excess of the latter value were found at a few stations; viz, Spokane, 3.5 to 5.7 meters per second from 2 to 4 kilometers; Omaha, between 3.0 and 4.1 meters per second from 0.5 to 1.5 kilometers. Similar excessive negative departures were found over several stations, viz, Chicago, 3.3 to 3.7 meters per second at 2 and 2.5 kilometers; Detroit, about 3.1 at 3 and 4 kilometers; St. Louis, 3.8 at 5 kilometers.

Table 5 shows maximum free-air wind velocities and directions for various sections of the United States during August as determined by pilot balloon observations. The extreme maximum was 42.0 meters per second from the southwest at 10,935 meters above sea level over Modena, Utah.

The mean monthly specific humidities and equivalent potential temperatures are shown in tables 2 and 3, respectively. The mean maximum free-air values of these data were found to be centralized over the southeastern portion of the Western Plateau Region and contiguous areas to the east. Study of the patterns shown by the monthly resultant winds, and the lines of constant value of these two elements constructed on charts for the various levels discloses striking evidence of the probable existence, statistically at least, of a high-level anticyclone over the territory specified above. The three types of data referred to appear most consistent with this conclusion for levels from 3 to 5 kilometers above sea level, especially if it is assumed that the equivalent potential temperatures and the specific humidities undergo little change on the average in air masses transported along anticyclonic trajectories over the regions in question. The weather which prevailed during the month was such as to lead one to expect that the latter assumption is justifiable.

In general, marked contrasts occurred in the respective weather conditions over the western and eastern halves of the country. The Western Plateau Region to the Pacific coast and the central and southwestern Great Plains were dominated by outbreaks of polar and transitional polar air masses from the Canadian Northwest and from the North Pacific anticyclone which was rather strongly developed during the month. This situation led to the prevalence of warm and dry, subsiding (S) air masses near the surface over much of this area. However, at times, owing to the relatively high pressure to the south and east, partly as a consequence of the well-developed North Atlantic anticyclone which frequently lay off the east coast, considerable warm, moist, tropical Atlantic (T_A) air moved in two streams from the Gulf of Mexico: northwestward over the Plateau region and the southwestern Great Plains, as well as north and northeastward over the Mississippi Valley and the southeastern part of the country. Over the first of these localities the T_A air frequently overlay and mixed with the S air. The elevated terrain here caused the air masses to be relatively warm as compared with those in the free air over the surrounding lower terrain. The isentropic surfaces were thus depressed over the Plateau region and contiguous areas immediately to the east which thus became a sort of stagnant reservoir of moisture-laden air at moderate and high levels that may be identified with the high-level Plateau anticyclone previously mentioned. The result of these conditions was great deficiency in precipitation (10 to 50 percent of normal) from the Pacific coast to the Mississippi except in the extreme northwestern, north-central and south-central parts of the country where precipitation was copious (100 to 200 percent of normal).

The precipitation over the extreme northwest was associated with several cyclones from the Pacific formed by the interaction of T_P and P_P air.

The rainfall over the north-central region mostly had its genesis on many occasions by the motion of T_A air from the southwestern reservoir anticyclonically northeast and eastward upward along the slopes of the dome shaped isentropic surfaces within the polar and transitional polar air masses passing over the north-central locality in question.

On some occasions weakly-developed cyclones associated with occluded fronts formed by action of N_P and T_A air were effective in producting the rather plentiful precipitation observed over much of the eastern third of the country. In these cases, troughs of T_A air above the cyclones were the immediate sources of the rain which was frequently of the shower type. The ascent of T_A air up the inverted-saucer-like slopes of the isentropic surfaces within the North Atlantic anticyclone lying along the east coast was also important for the precipitation in that area.

TABLE 1.—*Mean free-air temperatures (t), °C obtained by airplanes during August 1937. (Dep. represents departure from "normal" temperature)*

Station	Number of obs.	Altitude (meters) m. s. l.																	
		Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.
Barksdale Field [1] (Shreveport), La. (52 m)	31	24.1	−0.2	25.4	−0.7	23.0	−0.5	19.7	−0.3	16.4	−0.4	13.2	−0.5	10.2	−0.7	4.5	−0.5	−1.2	−0.4
Billings, Mont.[2] (1,090 m)	12	18.8						21.7		19.0		15.8		12.1		4.7		−2.5	
Boston, Mass.[1] (5 m)	28	20.8	+1.4	22.0	+1.8	19.7	+2.0	16.9	+2.2	14.1	+2.1	11.4	+1.9	8.7	+1.6	3.5	+1.8	−2.3	+1.6
Cheyenne, Wyo.[2] (1,873 m)	29	16.6	+1.4							17.9	+1.3	19.2	+1.6	16.1	+1.3	8.3	+1.2	−0.2	+0.9
Chicago, Ill.[2] (187 m)	31	20.3	+1.5	22.8	+2.0	20.1	+0.9	17.0	+1.0	13.9	+1.1	10.7	+0.7	7.5	+0.4	1.8	+0.5	−3.5	+1.0
Coco Solo, Canal Zone [3] (15 m)	23	25.5		23.6		21.1		18.4		15.6		13.6		11.1		4.7		−1.4	
El Paso, Tex.[2] (1,194 m)	30	23.7	+0.6					25.6	+1.1	22.6	+0.6	19.0	+0.6	15.1	+0.5	7.3	+0.5	0.2	+0.5
Fargo, N. Dak.[2] (274 m)	30	18.9	+2.4	21.7	+2.4	22.2	+3.4	20.2	+3.6	17.5	+3.7	14.1	+3.1	10.8	+3.0	4.1	+2.7	−3.1	+2.2
Kelly Field (San Antonio), Tex.[1] (206 m)	31	25.2	+1.4	24.8	+0.6	23.7	+0.9	20.8	+0.4	16.9	−0.3	13.4	−0.8	10.3	−1.0	4.2	−1.0	−1.0	−0.1
Lakehurst, N. J.[3] (39 m)	22	20.5	+1.0	21.5	+1.2	18.5	+0.7	15.7	+0.6	13.0	+0.5	10.4	+0.2	7.5	−0.3	2.1	−0.4	−2.2	+0.2
Maxwell Field (Montgomery), Ala.[1] (52 m)	30	24.5	+0.2	24.2	−0.5	21.2	−1.0	17.8	−1.2	14.7	−1.3	11.7	−1.5	8.9	−1.5	3.3	−1.4	−1.7	−0.9
Mitchell Field (Hempstead, L. I.), N. Y.[1] (29 m)	22	20.8	+1.6	22.1	+1.9	20.0	+1.9	17.2	+2.0	14.8	+2.2	11.9	+2.0	9.1	+1.7	3.6	+1.6		
Nashville, Tenn.[2] (180 m)	31	22.8	+0.4	24.5	+0.5	21.9	0.0	18.6	0.0	15.5	0.0	12.3	−0.1	9.3	−0.1	3.9	+0.4	−1.6	+0.8
Norfolk, Va.[3] (10 m)	25	22.9	−0.9	22.4	−0.1	19.6	−0.5	16.9	−0.2	13.9	−0.1	11.1	−0.2	8.0	−0.6	1.8	−1.2	−4.0	−1.6
Oakland, Calif.[2] (2 m)	31	13.8		18.4		23.9		21.8		19.0		15.8		12.5		5.5		−1.5	
Oklahoma City, Okla.[2] (391 m)	31	24.6	−0.2	25.6	−0.6	26.3	+0.2	23.2	+0.4	19.6	+0.3	15.9	+0.1	11.9	−0.4	5.0	−0.5	−1.8	−0.7
Omaha, Nebr.[2] (300 m)	31	23.1	+2.9	24.7	+2.9	24.7	+2.2	22.2	+1.9	19.5	+2.0	16.1	+1.8	12.6	+1.6	6.0	+1.8	−0.7	+1.8
Pearl Harbor, Territory of Hawaii [3] (6 m)	31	23.7	−1.3	21.9	0.0	18.7	+0.5	16.0	+0.5	14.2	+0.7	12.9	+1.2	11.0	+1.5	5.6	+0.8	0.1	+1.7
Pensacola, Fla.[3] (13 m)	28	23.8	−0.9	23.8	+0.2	20.8	0.0	17.9	+0.2	15.1	+0.3	12.2	+0.3	9.4	+0.4	3.8	+0.6	−1.4	+0.7
St. Thomas, Virgin Islands [3] (8 m)	31	28.8		24.6		21.2		18.5		15.9		13.5		11.0		5.4		0.0	
Salt Lake City, Utah [2] (1,288 m)	30	19.7						24.7		22.7		19.1		15.5		7.4		−0.5	
San Diego, Calif.[3] (10 m)	29	19.2	−1.7	17.4	−1.7	23.7	+0.5	24.0	+1.6	21.4	+1.0	18.2	+1.2	14.8	+1.2	7.4	+0.8	−0.1	0.0
Sault Ste. Marie, Mich.[2] (221 m)	31	16.1		18.9		18.2		15.9		13.5		10.8		8.1		2.2		−4.1	
Scott Field (Belleville), Ill.[1] (135 m)	26	20.6	−0.2	24.9	+0.3	22.4	−0.4	19.0	−0.8	15.8	−0.9	12.6	−0.9	9.9	−0.6	4.0	−0.1	−1.6	+0.4
Seattle, Wash.[3] (10 m)	16	16.3		13.8		11.7		9.3		7.1		4.8		2.6		−2.4		−8.2	
Selfridge Field (Mount Clemens), Mich.[1] (177 m)	26	19.6	+1.5	22.1	+1.7	19.5	+1.2	16.7	+1.1	13.6	+0.8	10.8	+0.8	8.3	+1.0	2.6	+1.1	−3.2	+1.5
Spokane, Wash.[2] (596 m)	31	13.6	−0.8			18.9	−0.7	16.6	−1.2	13.3	−0.6	9.3	−0.5	5.9	−0.3	−0.7	−0.6	−7.3	−0.4
Washington, D. C.[2] (13 m)	25	23.1	+1.0	23.4	+2.1	20.7	+1.4	17.8	+1.3	14.3	+0.7	11.4	+0.6	8.3	+0.3	2.8	0.0	−2.7	+0.2
Wright Field (Dayton), Ohio [1] (244 m)	27	19.2	−0.1	21.4	+0.1	21.5	+0.8	18.4	+0.7	15.3	+0.3	12.7	+0.5	10.2	+0.6	4.4	+0.6	−1.4	+0.6

[1] Army. [2] Weather Bureau. [3] Navy.

Observations taken about 4 a.m. 75th Meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Barksdale, 93 (3); Boston, 74 (3); Cheyenne, 122 (4); Chicago, 92 (3); El Paso, 92 (3); Fargo, 123 (4); Kelly Field, 124 (4); Lakehurst, 76 (3); Maxwell Field, 117 (4); Mitchel Field, 109 (4); Nashville, 124 (4); Norfolk, 170 (8); Oklahoma City, 123 (4); Omaha, 208 (7); Pearl Harbor, 164 (6); Pensacola, 235 (9); San Diego, 232 (9); Scott Field, 114 (4); Selfridge Field, 119 (4); Spokane, 124 (4); Washington, 216 (9); Wright Field, 120 (4).

TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during August 1937. (Dep. represents departure from "normal" relative humidity)*

Stations	Number of observations	Altitude (meters) m. s. l.																					
		Surface			500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.	
			Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.
Barksdale Field, La.	31	16.8	90	+6	13.8	65	+2	12.5	64	+1	11.2	66	0	9.6	66	0	8.0	64	+1	7.0	64	+4	4.9	59	+4	3.3	53	+2
Billings, Mont.	12	6.4	42								6.9	36		6.2	36		5.8	39		5.2	42		4.1	48		2.6	45	
Boston, Mass.	28	13.3	87	+4	12.5	72	+6	11.2	70	+4	10.2	72	+5	8.7	70	+7	7.5	67	+10	6.1	62	+7	4.4	57	+8	3.3	56	+13
Cheyenne, Wyo.	29	8.6	59	−4										8.5	53	−5	7.6	41	−6	6.4	40	−5	4.8	45	−4	3.9	56	−1
Chicago, Ill.	31	13.1	87	+2	12.6	69	0	11.1	68	+5	9.1	64	0	7.7	62	−2	6.5	61	+3	5.1	57	+5	3.5	50	+5	2.2	41	+3
Coco Solo, Canal Zone	23	18.9	94		17.0	89		14.6	84		12.8	82		11.5	83		8.8	68		6.9	60		5.4	64		3.9	61	
El Paso, Tex.	30	11.0	53	−5							10.2	42	−7	9.2	43	−6	8.7	48	−6	7.9	52	−7	6.6	66	−5	5.1	74	+1
Fargo, N. Dak.	30	11.3	81	+3	10.8	63	+1	9.3	50	−4	7.7	45	−7	6.7	43	−8	5.4	41	−7	4.7	41	−8	3.5	44	−3	2.7	48	+2
Kelly Field, Tex.	31	15.7	77	−10	15.6	76	−9	12.2	60	−9	10.7	59	−4	9.6	64	0	7.9	62	+2	6.1	56	+1	4.0	49	−2	2.7	41	−9
Lakehurst, N. J.	22	14.1	94	+3	11.3	67	−2	10.0	68	+1	8.6	65	−1	7.2	61	−2	6.0	57	−2	4.8	53	−2	3.8	53	−3	1.1	22	−21
Maxwell Field, Ala.	30	16.7	87	−1	14.9	75	+2	12.8	73	+1	11.4	76	+3	9.5	73	+3	8.1	72	+5	7.0	70	+5	5.3	69	+8	3.7	59	+6
Mitchel Field, N. Y.	22	14.3	94	+2	13.4	77	+3	12.4	77	+6	11.2	78	+6	9.8	74	+4	8.0	70	+6	7.0	69	+9	4.5	58	+4			
Nashville, Tenn.	31	14.6	83	−4	13.7	68	−2	13.0	71	+1	11.5	73	+1	9.4	69	−1	7.8	66	0	6.4	62	0	4.1	51	−5	2.6	42	−6
Norfolk, Va.	25	15.8	91	+9	13.8	78	+6	12.0	76	+8	10.1	72	+6	8.5	69	+3	7.2	66	+3	6.0	64	+5	4.2	61	+11	2.8	56	+12
Oakland, Calif.	31	8.6	88		8.9	64		6.4	31		5.2	27		3.7	22		3.0	20		2.3	19		1.6	19		1.0	18	
Oklahoma City, Okla.	31	14.7	73	+7	14.7	68	+6	12.8	54	0	11.6	55	+1	10.7	60	+4	9.2	62	+6	8.1	66	+9	5.4	63	+7	3.1	53	+1
Omaha, Nebr.	31	14.4	79	0	14.1	69	+1	12.4	57	+3	10.8	55	+3	9.2	52	+1	8.2	54	+3	7.2	56	+5	4.8	52	+2	3.2	50	+1
Pearl Harbor, Hawaii	31	14.2	78	+4	13.5	78	0	12.6	84	+1	10.7	80	+1	8.8	70	+1	6.1	50	−4	4.7	41	−4	3.2	35	+3	2.7	40	+8
Pensacola, Fla.	28	17.2	94	+6	16.1	83	+4	13.6	80	+4	11.6	77	+3	9.7	73	+2	8.1	70	+2	6.9	67	+2	5.2	65	+2	3.7	61	+4
St. Thomas, Virgin Islands	31	18.7	76		18.2	90		15.1	87		12.7	81		10.6	75		8.1	64		6.6	57		4.8	55		3.4	49	
Salt Lake City, Utah	30	8.3	50								9.4	41		8.0	37		6.8	37		5.8	38		4.5	45		3.6	54	
San Diego, Calif.	29	11.6	83	+3	11.1	85	+6	9.2	45	−2	6.3	29	−9	5.5	28	−8	5.0	29	−9	4.7	31	−10	3.6	35	−10	2.9	41	−4
Sault Ste. Marie, Mich.	31	10.4	90		9.6	67		9.2	63		7.9	60		7.0	58		5.6	52		4.5	47		3.0	42		2.0	39	
Scott Field, Ill.	26	13.5	89	+3	12.6	61	+1	11.6	62	+2	10.6	66	+6	8.7	62	+5	6.8	57	+3	5.5	52	+2	3.5	44	−2	1.5	24	−14
Seattle, Wash.	16	8.3	73		7.7	74		6.7	70		6.0	70		5.0	62		4.0	56		3.3	51		2.2	43		1.3	36	
Selfridge Field, Mich.	26	12.8	89	+4	11.0	63	−2	9.4	60	−2	8.5	60	+2	7.0	57	+2	5.7	53	+1	4.6	48	−1	3.2	44	−2	2.3	42	0
Spokane, Wash.	31	6.8	66	+6				6.3	41	−2	5.7	41	+1	5.4	46	+3	5.1	52	+5	4.3	53	+5	2.7	46	+2	1.8	45	+3
Washington, D. C.	25	15.0	86	+8	12.6	67	0	11.0	65	+2	9.4	63	−1	8.5	67	+2	7.0	62	0	5.7	59	0	3.7	49	−2	2.7	45	−2
Wright Field, Ohio	27	13.0	92	+5	12.8	77	+3	12.1	68	0	10.5	68	−1	8.7	64	0	6.7	55	−5	5.0	47	−8	3.3	40	−10	2.2	36	−10

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (Θ_E), in °A, obtained by airplanes during August 1937*

Stations	Altitude (meters) m. s. l.																			
	Surface			500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Number of observations	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	
Barksdale Field, La	31	1,009	343	959	342	906	341	854	340	806	337	759	334	715	334	634	332	560	332	
Billings, Mont	12	893	321					851	330	803	330	757	331	714	331	632	331	558	328	
Boston, Mass	28	1,017	329	960	334	907	333	856	333	807	331	759	331	716	329	633	329	560	331	
Cheyenne, Wyo	29	815	332							803	336	757	340	714	339	633	336	561	335	
Chicago, Ill	31	995	330	960	336	906	334	855	330	806	328	758	327	714	325	631	325	558	326	
Coco Solo, Canal Zone	23	1,009	351	955	349	902	345	851	342	803	342	756	337	713	335	631	334	559	334	
El Paso, Tex	30	882	340					852	344	804	343	758	344	715	342	634	341	561	340	
Fargo, N. Dak	30	980	326	955	330	902	332	851	331	803	330	756	328	712	328	630	328	557	329	
Kelly Field, Tex	31	994	344	961	346	908	341	856	339	808	337	761	334	717	331	635	329	562	330	
Lakehurst, N. J	22	1,013	332	959	330	905	329	854	328	804	326	758	325	713	324	631	327	559	324	
Maxwell Field, Ala	30	1,011	344	960	343	907	340	856	337	807	334	760	333	716	331	633	332	560	333	
Mitchel Field, N. Y	22	1,015	332	962	336	907	337	856	336	807	335	760	332	715	332	634	330			
Nashville, Tenn	31	995	337	960	341	906	341	855	339	806	335	759	333	715	331	633	329	560	329	
Norfolk, Va	25	1,017	339	961	339	908	336	856	333	807	330	760	329	716	328	633	327	559	327	
Oakland, Calif	31	1,014	310	957	321	903	325	853	324	804	323	758	322	714	322	632	323	559	324	
Oklahoma City, Okla	31	969	343	957	345	905	346	854	345	806	344	760	341	716	338	634	334	561	330	
Omaha, Nebr	31	979	339	957	342	905	343	854	341	806	339	760	338	716	337	634	333	562	332	
Pearl Harbor, Territory of Hawaii	31	1,015	336	960	337	906	337	855	334	806	332	760	328	717	327	636	328	563	331	
Pensacola, Fla	28	1,017	344	962	347	908	341	857	338	808	335	761	333	717	332	634	332	561	333	
St. Thomas, Virgin Islands	31	1,017	354	962	353	908	347	856	343	808	339	761	334	717	333	635	333	562	334	
Salt Lake City, Utah	30	871	329					850	341	803	340	757	338	714	337	633	334	560	334	
San Diego, Calif	29	1,012	324	957	326	904	333	852	331	805	331	758	331	715	332	634	332	562	332	
Sault Ste. Marie, Mich	31	991	318	959	323	905	327	853	326	804	326	756	325	713	324	630	324	557	325	
Scott Field, Ill	26	1,001	331	960	338	907	338	855	337	807	333	758	330	716	329	633	327	561	326	
Seattle, Wash	16	1,019	311	961	312	906	312	852	313	803	313	754	314	709	315	626	317	552	318	
Selfridge Field, Mich	26	996	328	960	330	906	329	854	328	805	326	758	325	714	324	631	325	558	327	
Spokane, Wash	31	946	310			902	319	850	321	802	322	754	322	710	321	627	321	554	321	
Washington, D. C	25	1,017	337	962	336	908	334	857	331	808	331	761	329	716	327	634	326	560	329	
Wright Field, Ohio	27	989	330	960	334	906	338	855	336	806	333	760	330	716	327	633	327	560	328	

TABLE 4.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during August 1937*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Nashville, Tenn. (194 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	337	1.1	119	0.2	326	1.8	267	0.9	279	2.7	195	0.7	43	0.7	270	0.8	144	2.6	30	0.3	102	2.6	209	0.2	174	1.0
500			225	2.2			290	4.0			203	3.4	168	1.3	259	1.6	172	5.0	198	5.1	110	5.3	239	0.6	204	3.3
1,000			253	2.5			279	4.7			234	2.7	241	3.2	251	2.8	213	6.4	180	4.7	120	5.2	303	1.9	221	3.2
1,500			249	1.2	95	1.1	273	4.8			268	2.4	258	3.1	259	2.9	252	6.8	163	3.7	115	4.2	326	0.6	230	2.9
2,000	177	1.5	223	0.6	208	1.0	256	5.2	258	4.5	302	1.5	268	3.2	281	3.0	274	6.9	130	2.7	117	3.7	288	0.9	235	2.8
2,500	197	2.4	196	1.0	239	4.0	263	4.9	232	5.1	334	1.9	272	3.0	283	2.5	281	8.0	103	2.7	123	3.3	242	3.4	241	3.0
3,000	219	2.3	179	1.3	251	6.6	267	5.5	234	4.4	345	3.5	287	3.0	313	2.5	291	9.4	78	2.6	123	2.8	236	6.2	259	2.4
4,000	245	1.2	176	1.1	253	11.0	266	9.0	250	5.0					320	3.1	290	10.0	82	2.7	200	1.2	238	8.3	340	3.4
5,000	227	0.5							247	5.4					297	5.1			54	4.0			250	10.6		

Altitude (m) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii [1] (68 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	213	0.5	282	1.1	171	3.4	149	2.4			359	0.8	153	1.0	147	4.5			128	0.5	132	0.8	138	1.0	268	0.6
500	301	3.6	246	2.7	185	7.1	174	6.7			103	1.0	180	4.5					227	2.1	113	0.2			237	3.6
1,000	291	3.7	300	4.5	208	11.5	200	9.4			154	1.1	213	3.1					262	5.8	166	0.6	216	3.4	261	2.6
1,500	274	4.0	287	2.5	213	7.0	222	8.4			135	1.8	262	2.3	160	6.4			275	5.6	220	1.8	238	5.2	257	3.1
2,000	270	5.4	248	2.8	222	3.2	240	5.6			114	2.5	296	1.9	180	5.5			273	5.4	262	2.6	237	6.8	273	2.9
2,500	276	5.6	217	3.4	252	0.7	256	3.9			102	3.0	320	1.8	206	4.3			278	5.7	278	4.1	240	8.5	276	4.2
3,000	290	6.7	210	2.9	351	1.1	288	2.9			107	3.2	298	1.6	224	5.4			286	6.8	283	5.3	245	10.2	260	5.2
4,000	266	8.4			49	1.2	307	3.3					295	2.4	250	6.4			298	7.2	262	7.2	239	12.3	264	4.4
5,000							261	3.3					347	0.9												

[1] Navy stations.

TABLE 5.—*Maximum free air wind velocities (meters per second), for different sections of the United States based on pilot balloon observations during August 1937*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station
Northeast [1]	25.0	SW	1,184	11	Newark	24.5	WSW	4,263	20	Pittsburgh	34.0	WNW	9,000	18	Albany.
East-Central [2]	19.0	SSE	1,184	31	Nashville	18.0	WSW	3,340	13	Washington	32.4	NE	10,360	16	Washington.
Southeast [3]	25.7	SSE	620	30	Jacksonville	20.5	SW	4,440	7	Charleston	21.5	NE	12,360	20	Charleston.
North-Central [4]	33.2	SW	1,080	23	Fargo	26.7	W	4,568	18	Bismark	38.0	N	10,190	25	Detroit.
Central [5]	25.6	SW	124	7	Wichita	24.8	WSW	4,445	11	Davenport	36.0	N	8,980	1	Indianapolis.
South-Central [6]	29.8	SSE	2,020	21	Del Rio	17.2	NNE	4,270	11	Amarillo	32.0	N	18,670	24	Amarillo.
Northwest [7]	30.6	WSW	2,133	18	Spokane	39.0	SW	4,460	22	Medford	36.0	WSW	7,533	15	Spokane.
West-Central [8]	32.9	SW	2,500	22	Winnemucca	34.8	WSW	3,760	13	Winnemucca	42.0	SW	10,935	24	Modena.
Southwest [9]	24.0	SSW	984	28	Las Vegas	31.1	SW	4,100	27	Havre	28.4	SW	10,200	3	Las Vegas.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD, in Charge]

By BENNETT SWENSON

During August 1937 floods occurred principally in the Susquehanna River Basin, in portions of the South Atlantic drainage area, and in the Arkansas River Basin.

Rains on August 26–27, heavy over portions of the Susquehanna watershed, resulted in local flooding in some of the tributaries of the Susquehanna River. The damage was especially heavy in the vicinity of Wellsboro, Pa., as the result of excessive rainfall over a small area between Wellsboro and Corning, N. Y. At the former place 7.39 inches were recorded between 4 and 9 a. m. of the 27th, and 6.01 inches were reported at the latter point between 9 a. m. and 10:30 p. m. of the same date. All of the small mountain streams draining into Pine Creek were within the area of the overflow. The total damage in the vicinity of Wellsboro as a result of the storm and flood has been estimated at $645,000.

Moderate floods were in progress in the rivers of eastern North Carolina at the close of the month and full information on flood damage will be included in the next issue of the REVIEW.

Overflows in the Saluda and Santee Rivers in South Carolina during the latter part of August and the first few days of September were light and no damage of consequence occurred.

Local floods occurred in the Ninnescah and North Canadian Rivers, tributaries of the Arkansas River. The overflow in the Ninnescah River in Kansas was greatest between Kingman and Oxford and resulted in damage estimated at $115,000 in this area. The flooding in the North Canadian River in Oklahoma was slight and no damage of consequence was reported.

Table of flood stages during August 1937

[All dates in August unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
	Feet			*Feet*	
Tioughnioga: Whitney Point, N. Y.	12	27	27	12.2	27
James: Columbia, Va.	10	26	[1] 28	11.3	28
Dan: Danville, Va.	11	26	26	13.4	26
Roanoke:					
Weldon, N. C.	31	25	30	37.5	28
Scotland Neck, N. C.	23	25	[2]	28.9	30
Williamston, N. C.	10	30	[2]	10.4	31
Tar:					
Rocky Mount, N. C.	8	26	[2]	11.1	27, 29, 30
Tarboro, N. C.	18	30	[2]	21.9	Sept. 1
Greenville, N. C.	13	31	[2]	16.2	Sept. 3
Little: Kenly, N. C.	8	26	31	10.0	27
Neuse:					
Neuse, N. C.	14	25	31	18.2	26
Smithfield, N. C.	13	25	[2]	18.1	29
Goldsboro, N. C.	14	29	[2]	18.6	Sept. 3
Saluda: Pelzer, S. C.	6	13	16	7.1	14
Santee:					
Rimini, S. C.	12	July 28	1	12.5	July 30
		27	[2]	13.0	30
				13.4	Sept. 3
Ferguson, S. C.	12	29	[2]	12.9	Sept. 6
MISSISSIPPI SYSTEM					
Ohio Basin					
West Fork of White: Anderson, Ind.	8	9	16	10.5	13
		21	23	8.1	21
Arkansas Basin					
North Canadian:					
Canton, Okla.	6	22	22	6.0	22
Yukon, Okla.	8	23	25	9.1	24

[1] Fell 0.6 below flood stage on 27th.
[2] Above flood stage at end of month.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, WILLIS E. HURD, acting in charge]

NORTH ATLANTIC OCEAN, AUGUST 1937

By H. C. HUNTER

Atmospheric pressure.—The departures of average pressure from normal were more pronounced than is usual in the case of a summer month. Over waters near Greenland and western Iceland the deficiency was large, Julianehaab, Greenland, reporting 0.20 inch. On the other hand, the vicinity of the British Isles had a marked excess; at Lerwick it was 0.22 inch.

The waters near the American coast from the Carolinas to southern Labrador had pressure moderately above normal. In general, portions of the North Atlantic near or to southward of the 40th parallel had pressure averages slightly greater than normal, save the Antilles-Caribbean region.

The pressure extremes of vessel reports at hand for the month are 30.47 and 29.06 inches. The higher reading was noted approximately 400 miles to south-southwestward of Horta, during the forenoon of the 23d, on the French steamship *Capitaine Paul Lemerle*. The lower reading was radioed by an unidentified steamer during the final evening of the month, the position being about latitude 56° north, longitude 31° west. Other readings very nearly as low were reported earlier in the day by vessels in that vicinity.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, August 1937*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.62	−0.20	29.94	7	29.20	18
Reykjavik, Iceland	29.69	−.12	30.09	29	29.06	12
Lerwick, Shetland Islands	30.02	+.22	30.39	26	29.53	17
Valencia, Ireland	30.08	+.16	30.42	26	29.65	16
Lisbon, Portugal	30.02	.00	30.18	19	29.80	16
Madeira	30.05	+.02	30.21	24	29.89	17
Horta, Azores	30.22	+.02	30.42	15	29.82	3
Belle Isle, Newfoundland	29.96	+.07	30.42	31	29.36	17
Halifax, Nova Scotia	30.09	+.08	30.40	23	29.78	18
Nantucket	30.07	+.08	30.31	30	29.81	13
Hatteras	30.10	+.10	30.29	30	29.90	5
Bermuda	30.19	+.05	30.30	22	30.08	28
Turks Island	30.00	−.04	30.08	7	29.85	26
Key West	29.98	.00	30.12	15	29.82	28
New Orleans	30.00	+.02	30.22	16	29.78	29

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket and New Orleans, which are 24-hour corrected means.

Extra-tropical cyclones and gales.—Gales connected with low-pressure areas of extra-tropical origin were not numerous, and were noted chiefly during the final 9 days of the month. Low pressure covered many northern regions for days in succession during this period and especially low readings were noted during the last day in a section about midway between the southern tip of Greenland and southwestern Ireland. For vessels operating along the chief steamship lanes the strong winds connected with these low-pressure areas blew mainly from a southerly or southwesterly direction.

In just one instance was a wind force as great as 10 recorded in connection with any low-pressure area to northward of the 45th parallel. This was on the 25th or 26th, when the Belgian steamship *Emile Francqui*, westbound, was near midocean.

Tropical disturbances.—No phenomenally strong winds occurred in connection with the disturbances which started within or close to the Tropics. The first of these, forming in July, was discussed in the REVIEW of that month. It was centered not far to southeastward or eastward of the New England coast on August 1, and the first 5 gales shown in the accompanying table occurred in connection with that storm. A somewhat similar path was taken by the second disturbance, which advanced from the Bahamas to near Sable Island during the 2d to 8th. Four resulting gales during the period 5th–8th are included in the table.

The third disturbance moved from northeast of the Lesser Antilles, on the 30th, to the northeast coast of Florida, which it crossed on the 30th. Five reports of gale-force winds, met in no case before the 28th, are connected with this storm and may be found in the accompanying table.

A special report on the latter two disturbances appears elsewhere in this issue of the REVIEW.

Fog.—Reports at hand mostly indicate less fog during August than there had been during the July preceding, especially around the British Isles. However, near Nova Scotia and New England August is indicated as the foggier month of the two. These waters adjacent to New England, in fact, had much more fog than the average amount in previous Augusts. The 5° square, 40° to 45° N., 65° to 70° W., led all other North Atlantic squares in frequency, with 23 days.

Near the Grand Banks and Newfoundland the leading square was that from 40° to 45° N., 45° to 50° W., where 14 days had fog. The first week of August was nearly free from fog in the Grand Banks area.

Near Delaware Bay and to southward there was practically nowhere any fog. To southward of the 35th parallel of latitude no part of the North Atlantic has reported fog or an atmospheric condition resembling fog, save that on the 12th there was very limited visibility in a section to southward of the Canary Islands, close to the west coast of Africa. Such a condition in that section seems usually due to very fine sand blown from the African mainland.

At a late hour of the 11th, in dense fog, the British steamship *Duchess of Atholl* and the Danish steamship *Maine* collided about 180 miles to southeastward of Boston. The latter presently sank, after her crew abandoned her, while the former made port, somewhat damaged. On the 12th the steam drifter *Oswy* was sunk in the North Sea, off Tynemouth, by collision during prevalence of fog, and 3 of her crew of 9 were reported missing.

OCEAN GALES AND STORMS, AUGUST 1937

Vessel	Voyage		Position at time of lowest barometer		Gale began August—	Time of lowest barometer August—	Gale ended August—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Wellfield, Br. M. S.	Boston	Carapita	37 55 N.	68 00 W.	[1] 31	1a, 1	1	29.91	SW	WSW, 8	W	SW, 9	SW-W.
Bergensfjord, Nor. S. S.	New York	Bergen	41 00 N.	67 25 W.	1	8a, 1	2	29.58	NE	NNW, 8	S	NNW, 8	ENE-NNW-SW.
Volendam, Du. S. S.	do	Rotterdam	41 11 N.	63 37 W.	1	Noon, 1	1	29.80	SSE	SSE, 8	SSW	SSE, 8	SSE-S.
Normandie, Fr. S. S.	Southampton	New York	40 53 N.	65 20 W.	1	Noon, 1	1	29.64	SW	W, 10	W	WSW, 10	SW-W.
Sarcoxie, Am. S. S.	Havre	do	42 00 N.	64 15 W.	1	3p, 1	1	29.75	SSE	SW, 8	WSW	SW, 8	S-SW.
Ceres, Du. S. S.	Amsterdam	San Juan	44 36 N.	31 45 W.	3	10a, 2	3	30.14	NE	S, 3	NE	NE, 8	S-NE.
Bienville, Am. S. S.	Mobile	Liverpool	33 24 N.	76 30 W.	6	7a, 5	6	29.88	SE	ENE, 6	S	SE, 10	ENE-NE.
Andrea F. Luckenbach, Am. S. S.	Colon	New York	34 33 N.	74 00 W.	5	8p, 5	6	29.81	SSE	SE	E	E, 8	SE-E.
Atlantis, Am. Ketch		Woods Hole	37 36 N.	71 24 W.	6	9p, 6	7	[2]29.80	SE	SE, 10	NW	SE, 10	SE-NE.
American Trader, Am. S. S.	London	New York	41 10 N.	65 50 W.	7	Mdt, 7	8	29.67	SE	SSW, 9	W	SSW, 9	SE-W.
Poseidon, Du. S. S.	Savannah	Glasgow	54 39 N.	13 48 W.	23	4a, 24	24	29.77	SSW	SSW, 7	NW	SSW, 8	None.
Montreal City, Br. S. S.	Fowey	Portland, Me.	50 36 N.	27 15 W.	24	7p, 24	25	29.67	S	SW, 9	Var	SW, 9	S-NW.
Pres. Roosevelt, Am. S. S.	Cobh	New York	[3]47 56 N.	35 58 W.	24	2a, 25	25	29.84	SSE	SW, 7	SW	S, 9	S-NW.
Emile Francqui, Belg. S. S.	Antwerp	do	47 45 N.	34 40 W.	25	2p, 25	26	29.85	S	S, 9	W	S, 10	
Volendam, Du. S. S.	Rotterdam	do	50 06 N.	33 44 W.	25	7p, 25	25	29.54	SSW	S, 8	NNW	S, 8	SSE-WSW-NNW.
Beemsterdijk, Du. S. S.	do	do	[3]50 48 N.	25 59 W.	25	6a, 26	26	29.83	S	S, 6	S	S, 8	S-NW.
Patrick Henry, Am. S. S.	New Orleans	London	48 15 N.	26 45 W.	26	3a, 27	29	29.91	SSW	SW, 7	N	SW, 8	SW-N.
Colombia, Am. S. S.	New York	Port au Prince	27 39 N.	74 05 W.	28	3p, 28	29	29.84	SE	SE, 7	SE	SE, 8	None.
C. A. Canfield, Am. S. S.	Paulsboro	Cristobal	25 34 N.	74 18 W.	28	4p, 28	29	29.88	SE	SSE, 7	SE	S, 8	SE-SSE.
Bergensfjord, Nor. S. S.	Bergen	New York	54 35 N.	36 00 W.	27	8a, 29	30	29.50	SSW	SE, 2	NW	W, 9	W-SE-NW.
Solana, Am. S. S.	New York	Lockport	28 36 N.	78 38 W.	29	6p, 29	30	29.75	SE	SE, 10	S	SE, 10	None.
Matagalpa, Am. M. S.	Baltimore	New Orleans	28 30 N.	78 40 W.	29	7p, 29	29	29.69	ESE	ESE, 9	ESE	ESE, 9	ESE-SSW.
Gulfoil, Am. S. S.	Philadelphia	Port Arthur	30 00 N.	80 15 W.	29	5a, 30	30	29.79	E	SE, 9	SSE	SE, 9	ESE-SE.
American Trader, Am. S. S.	London	Boston	[3]49 19 N.	24 51 W.	30	3a, 31	[4]1	29.61	SW	SW, 6	NW	W, 8	SW-W.
NORTH PACIFIC OCEAN													
Corneville, Nor. M. S.	Hong Kong	Los Angeles	21 06 N.	126 06 E.	1	8p, 1	3	29.24	W	W, 6	S	S, 11	W-S.
California, Am. S. S.	Los Angeles	Acapulco	21 05 N.	107 38 W.	4	6a, 4	4	29.78	ESE	ESE, 7	SE	ESE, 7	
Steel Navigator, Am. S. S.	Shanghai	Manila	28 06 N.	122 06 E.	9	8a, 8	9	29.61	SW	SW, 6	SW	SW, 8	None.
Si-Kiang, Fr. S. S.	Hong Kong	Kobe	29 42 N.	122 48 E.	13	2p, 14	15	29.38	N	W, 7	S	WNW, 8	N-W-S.

[1] July. [2] Barometer uncorrected. [3] Position approximate. [4] September.

NORTH PACIFIC OCEAN, AUGUST 1937

By WILLIS E. HURD

Atmospheric pressure.—The Aleutian LOW, which had continued strongly in evidence through July, was practically nonexistent in August 1937. The average barometer over the eastern Aleutians was 0.15 inch or more higher than the normal. In the Gulf of Alaska, however, there was some reversal of barometric conditions, with Juneau, average barometer 29.92, showing a pressure departure from normal of −0.10.

Over the great central body of the ocean, pressure was mostly anticyclonic and high barometer prevailed from the northern coast of the United States far westward into east longitudes, and from Dutch Harbor to Honolulu; both of these stations had an average pressure of 30.01.

In the Far East, although several tropical disturbances occurred to the west and northwest of the Marianas, yet the average pressure at Guam was only 0.02 inch below the normal, while at Chichishima, in the Ogasawara Islands south of Japan, the August average, 29.94 inches, was 0.18 inch higher than the normal.

Cyclones and gales.—The weather in middle and high latitudes of the North Pacific was unusually quiet during August 1937. Several LOWS appeared over the Aleutian region, but these, so far as at present indicated, caused no winds of gale force. In middle latitudes the highest wind reported from other than a tropical disturbance was of force 7 from the north-northwest, near 36° N., 131° W., experienced by the Japanese motorship *Heiyo Maru*.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, August 1937*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.77	−0.12	30.18	25	29.24	3
Dutch Harbor	30.01	+.15	30.36	19	29.56	2
St. Paul	29.97	+.19	30.30	19	29.50	1
Kodiak	29.91	+.05	30.30	31	29.46	2
Juneau	29.92	−.10	30.20	16	29.40	3
Tatoosh Island	30.08	+.08	30.33	2	29.66	30
San Francisco	29.93	+.01	30.07	25	29.77	13
Mazatlan	29.88	+.04	29.98	17, 25, 26	29.74	29
Honolulu	30.01	.00	30.10	2	29.87	29
Midway Island	30.12	+.04	30.24	7, 8	29.90	30
Guam	29.80	−.02	29.89	28	29.74	10, 23, 24, 25
Manila	29.74	.00	29.83	21	29.59	2
Hong Kong	29.65	−.01	29.81	26	29.34	3
Naha	29.77	+.08	29.94	17, 23, 25, 28	29.03	1
Chichishima	29.94	+.18	30.06	16, 28	29.68	9

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Tropical disturbances—Typhoons.—Subjoined is an account of the typhoons and depressions on Far Eastern waters during August 1937, prepared by the Rev. Bernard F. Doucette, S. J., of the Philippine Weather Bureau. With further reference to the first typhoon there described, that of July 29–August 5, a report received from the Norwegian motorship *Corneville* shows that the storm was of near hurricane intensity on August 2 to the southeast of Taiwan. The ship, east-bound from Hong Kong, had a south gale of force 11 at 6 a. m. of that date, and at

8 p. m., near 21° N., 126° E., had a low barometer reading of 29.24.

Disturbances of the southeastern North Pacific.—Disturbed weather conditions occurred off the Central American west coast on August 2, and off the Mexican coast on the 3d. Cyclonic circulation, however, appeared only immaturely developed. By the 4th the unsettled condition had proceeded to the entrance to the Gulf of California, and here at 6 a. m. the American steamer *California* had an east-southeast wind of force 7, lowest barometer 29.78. Thereafter the disturbance apparently went seaward and disintegrated.

On August 31 the American steamer *Point Estero*, in connection with an east-southeast wind of force 6 and barometer 29.78 observed off the Mexican coast near Acapulco, reported a tropical disturbance in the vicinity. There were slight evidences of the northwestward movement of a small unsettled region until September 3, but no further development of it has later been reported.

Radio reports on the 31st from the American S. S. *General Sherman* showed the existence of an intense tropical cyclone west of the Revillagigedo Islands. At 2 p. m., in 18°12′ N., 117°30′ W., the vessel reported a northeasterly hurricane wind, barometer 29.29, and at 5 p. m., wind of a similar force from a northwesterly direction, barometer 29.12, in the same position. We have no further history of this storm.

Fog.—Fog lessened greatly since July over the northwestern part of the ocean. Along the central part of the northern steamer routes fog continued frequent, occurring on 20 to 30 percent of the days within the region 40°–50° N., 180° and 160° W. Along the Washington-Oregon coasts there were 4 days on which fog was reported; along the California coast, 11 days; and off the coast of Lower California, 2 days.

TYPHOONS AND DEPRESSIONS OVER THE FAR EAST, AUGUST 1937

Rev. BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Typhoon July 29–August 5, 1937.—For about 3 days, there was a strong steady current of Southwest monsoon air flowing over the Archipelago toward the ocean regions east of the Balintang Channel before any definite center manifested itself. Then, on July 29, about 300 miles east of Aparri, it was certain that a typhoon was developing. Stationary in this location for 2 days, it then moved slowly and irregularly in a generally northerly direction, inclining somewhat to the north-northwest August 1 and 2, when it was east-southeast of Ishigakijima. On August 3 the storm was quite close to China, after a rapid northwesterly movement across the Eastern Sea, a course which was followed into the continent. August 5 found it degenerated into a mild disturbance central about 300 miles west by north of Shanghai; no indications of it could be found on the following days.

This typhoon manifested its intensity when crossing the southern part of the Nansei (Loochoo) Islands. At noon (Manila time) August 2 Ishigakijima reported pressure of 734.5 millimeters (28.917 inches) with northwest winds, force 2. Winds of force 8 and 9 were reported during these days from ships in the Eastern Sea. Shanghai, August 4, 6 a. m. (Manila time), had a pressure of 743.1 millimeters (29.256 inches) with southeast winds, force 6.

In the Philippines, during the course of this typhoon, heavy rains fell over Central Luzon, resulting in extensive floods. Dikes along the rivers were broken by the high waters, resulting in the loss of much property and 28 lives, as reported by the newspapers of August 6.

Typhoon August 1–15, 1937.—A low-pressure area was observed August 1 about halfway between Guam and Yap. This apparently mild disturbance moved rather slowly in a northwesterly direction to a location about 600 miles east by north of Manila, where it intensified into a typhoon which began to move rapidly toward the north. It inclined to the northwest on August 12, a course which brought it, at 6 a. m. (Manila time) August 13, about 90 miles west of Naha. Continuing this northwesterly motion, it reached the vicinity of the mouth of the Yangtze River. After August 15 no trace of the storm could be found over the western part of the Yellow Sea, the region toward which it had been moving.

Similar to the typhoon earlier in the month, the Nansei (Loochoo) Islands felt the strength of this storm. August 12 at noon (Manila time) Naha had the pressure value of 746.0 millimeters (29.370 inches) with east-southeast winds, force 6. Ishigakijima at the same time had 746.5 millimeters (29.390 inches) north-northwest winds, force 6. Two days later, Gutslaff reported for the afternoon weather map a value of 749.1 millimeters (29.492 inches) with north-northeast winds, force 6, with the center passing a few hours later, within 100 miles to the east.

Typhoon August 11–16, 1937.—Originating about 180 miles south-southwest of Guam, this typhoon, quite fully developed, moved along a northwesterly course to the ocean regions east of Balintang Channel, where it filled up when over 300 miles from the Philippines. The observations received from the S. S. *Bahrein* indicate that the center and region of strong winds were very small and that the storm did not exert its influence over an extensive area.

Typhoon August 16–22, 1937.—From the Eastern Caroline Islands a depression appeared August 16, moving in a westerly direction. When it was central about 250 miles south of Guam, a northwesterly course was taken and the morning of August 18 found the storm of sufficient intensity to be called a typhoon. For the next 3 days, it traversed a northwesterly course across the ocean to a position about 250 miles east-northeast of Basco, Batanes Pr., where it recurved to the northeast, filling up during the afternoon after it had changed its course. This typhoon had little influence, if any, upon the weather of the Philippines.

Depression August 16–17, 1937.—A mild depression, apparently of minor importance, should be mentioned as forming about 120 miles south-southeast of Oshima, August 16, and moving westward across the Eastern Sea, disappearing into the continent late in the afternoon of August 17.

Depression August 21–22, 1937.—Over the western part of the China Sea, a depression formed a short distance east of Hainan Island, and moved westward, first appearing the morning of August 21. A short movement along a northwesterly course placed its center over the northern part of the Gulf of Tong King, where it inclined to the north, thus entering the continent.

Typhoon August 22–30, 1937.—The morning weather map of August 22 indicated a depression central about 120 miles west by south of Yap. The disturbance moved rather rapidly along a west-by-north course, and because of the rapid fall of pressure over the Archipelago, it was considered a typhoon (August 23). It continued along this west-by-north and west-northwest course across the Visayan Islands into the China Sea, not causing very high winds, yet accompanied by a decided fall in pressure.

On the morning of August 27, when in the China Sea about 350 miles west of Manila, there were indications that it was weakening, but the afternoon observations indicated renewed activity. During the next 3 days, the storm moved along a northwest and west course, south of Hainan Island into the Gulf of Tong King, and then entered Indochina. During these 3 days, many ships navigating over the western part of the China Sea reported winds of force 7 and 8, with pressures of 751.0 millimeters (29.567 inches) or thereabouts. August 29, at 3 p. m. (Manila time) Vinh, Indochina, had northwest winds, force 11, with pressure of 749.2 millimeters (29.496 inches) when the typhoon was about 60 miles northeast of the station.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, August 1937*

[For description of tables and charts, see REVIEW, January, p. 29]

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	80.9	+1.2	Decatur	103	10	2 stations	62	3	5.04	+0.51	Highland Home	14.78	Sylacauga	1.38
Arizona	81.8	+2.1	Quartzsite	119	4	Bright Angel	35	8	1.83	−.53	Nogales	8.16	2 stations	.00
Arkansas	82.3	+2.3	Conway	111	10	Lead Hill	55	13	3.45	−.13	De Queen	12.69	Corning	.22
California	73.0	+.6	2 stations	124	[1] 11	Boca	19	30	.01	−.09	South Lake	.72	247 stations	.00
Colorado	70.0	+4.5	Las Animas	110	[1] 9	2 stations	22	[1] 20	1.43	−.53	Crested Butte	4.62	Trinidad	T
Florida	81.3	−.1	2 stations	100	[1] 1	Hastings	60	5	8.68	+1.62	Carrabelle	18.91	Merritts Island	1.66
Georgia	79.7	+.2	Hawkinsville	100	20	Blairsville	57	[1] 1	6.33	+1.07	Glennville	13.50	Moultrie	2.93
Idaho	65.2	−1.1	2 stations	108	[1] 4	Warren	18	29	.34	−.31	Kellogg	2.16	36 stations	.00
Illinois	78.1	+3.9	Quincy	103	16	Freeport	50	22	2.39	−.93	Wheaton	6.38	Harrisburg	.17
Indiana	76.3	+2.8	Johnson	102	3	Marengo	49	1	3.56	+.18	Williams	7.15	Fort Wayne	.96
Iowa	77.8	+5.7	Logan	108	16	Postville (near)	49	23	3.99	+.45	Algona	10.22	Keosauqua	.72
Kansas	83.5	+5.8	4 stations	113	[1] 9	Tribune	52	22	2.06	−1.05	Kingman	8.04	Ulysses	.09
Kentucky	78.0	+2.4	5 stations	100	[1] 3	2 stations	53	[1] 1	3.63	−.07	Jenkins	7.70	Fords Ferry	.46
Louisiana	82.2	+.4	Shreveport	104	10	Ruston	64	11	5.53	+.47	Reserve	12.63	Grand Cane	1.56
Maryland-Delaware	75.6	+2.5	Cumberland, Md	100	19	Grantsville, Md	44	2	7.05	+2.46	Chestertown, Md	12.18	Hancock City, Md	3.44
Michigan	71.5	+4.7	Petoskey	98	15	Sidnaw	26	22	2.99	+.29	Lapeer	9.73	Grand Marais	.46
Minnesota	74.0	+6.5	Beardsley	108	15	3 stations	40	[1] 21	4.20	+1.01	Redby	9.84	Ada	1.43
Mississippi	82.2	+1.5	2 stations	107	10	Batesville	61	11	4.76	+.51	Fruitland Park	9.87	Holly Bluff	1.39
Missouri	80.5	+4.1	do	105	[1] 9	2 stations	51	[1] 6	2.05	−1.75	Clifton Hill	6.10	Fisk	.34
Montana	66.4	+1.6	Rock Springs (near)	108	13	Wisdom	18	29	.55	−.57	Sherburne Lake	1.73	4 stations	.00
Nebraska	80.2	+7.0	2 stations	112	[1] 9	Mullen	42	22	1.89	−.87	Hartington	5.36	Sheep Creek Camp No. 5.	T
Nevada	73.7	+3.1	Logandale	119	[1] 11	San Jacinto	27	31	.08	−.42	Sharp	1.20	29 stations	.00
New England	72.2	+5.2	Chelsea, Vt	100	30	Greenville, Maine	35	24	4.14	+.28	Otis (near) Mass	10.55	St. Albans, Vt	.34
New Jersey	75.3	+3.5	Flemington	100	20	Charlotteburg	45	15	6.82	+2.07	Belvidere	12.35	Newton	3.64
New Mexico	73.4	+3.1	Orogrande	108	8	Elizabethtown	31	20	1.56	−1.03	White Tail	6.88	Horse Springs	.00
New York	72.4	+4.9	Port Jervis	99	20	Indian Lake	37	15	4.98	+1.18	Bedford Hills	9.64	Lockport	1.03
North Carolina	76.9	+1.0	2 stations	99	[1] 9	Banners Elk	46	1	7.40	+1.86	Rock House	15.32	Belhaven	2.05
North Dakota	72.9	+6.6	New England	109	6	3 stations	40	[1] 20	1.52	−.49	McLeod	7.23	2 stations	.04
Ohio	74.7	+3.1	Gallipolis (near)	103	17	2 stations	48	2	3.20	−.18	Mt. Healthy	7.00	Mansfield	.92
Oklahoma	85.1	+3.7	3 stations	114	[1] 9	Boise City	53	21	3.08	+.16	Atoka	8.80	Pryor	.26
Oregon	63.7	−1.6	Hermiston	102	4	Seneca	13	28	.45	+.03	Seaside	4.16	11 stations	.00
Pennsylvania	73.5	+3.3	Ephrata	101	20	Hyndman	40	30	5.43	+1.17	Lawrenceville	11.29	Claysville	1.42
South Carolina	79.0	+.2	3 stations	98	[1] 9	Long Creek (near)	57	1	6.93	+1.23	Caesars Head	15.66	Blairs	1.96
South Dakota	78.2	+7.4	do	114	[1] 14	Camp Crook	40	3	1.86	−.27	Vermillion	9.90	Hopewell	T
Tennessee	79.3	+2.6	2 stations	106	10	Crossville	50	1	4.71	+.70	Copperhill	10.70	Union City	.93
Texas	85.3	+2.5	do	115	[1] 10	Mount Locke	55	16	2.18	−.13	Paducah	10.21	3 stations	.00
Utah	71.8	+2.1	St. George	111	12	2 stations	32	20	.75	−.30	Escalante	3.25	Richmond	.00
Virginia	75.5	+1.4	Lincoln	102	21	Mountain Lake	48	1	7.49	+3.10	Stuart	12.11	Mendota	3.14
Washington	63.1	−2.5	Wahluke (near)	106	4	Deer Park (near)	23	29	1.31	+.50	Quinault	7.22	Lost Creek	.00
West Virginia	74.4	+2.6	Martinsburg	101	19	Bayard	40	2	5.83	+1.71	Wardensville	14.44	Ravenswood	1.06
Wisconsin	73.5	+5.9	Wisconsin Dells	104	16	Laona	30	22	2.74	−.48	Mellen	6.50	Plum Island	.24
Wyoming	67.4	+3.5	3 stations	105	[1] 6	West Yellowstone	20	30	.55	−.54	Seminol Dam	2.64	7 stations	.00
Alaska (July)	56.0	+.6	Nenena	88	11	Portage	27	28	2.65	+.13	Yakutat	17.66	Barrow	T
Hawaii	74.8	.0	Haiku	94	12	Kanalohuluhulu	50	19	10.35	+3.97	Nauhi Gulch	47.48	Olowalu	.29
Puerto Rico	78.9	+.1	2 stations	97	24	2 stations	60	[1] 14	10.69	+3.24	Rio Blanco	22.42	Mona Island	3.55

[1] Other dates also.

TABLE 2.—*Climatological data for Weather Bureau stations, August 1937*

[Compiled by Annie E. Small by official authority U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice, on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F.*	°*F.*		°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In*
New England							**72.2**	**+4.8**										**83**	**4.33**	**+0.7**										**5.6**		
Eastport	76	67	85	29.97	30.05	+0.00	64.3	+3.6	86	17	73	52	4	55	30	60	58	87	1.22	−1.8	7	8.5	sw.	25	sw.	21	8	7	16	6.4	0.0	0.0
Greenville, Maine	1,070	6	40	28.89	30.07	.....	68.3	.....	91	26	81	35	24	56	42	64	61	....	1.65	.....	12	7.5	s.	17	.....	19	11	12	8	.....	.0	.0
Portland, Maine	103	82	117	29.93	30.05	+.07	72.4	+6.0	96	21	81	55	24	64	26	65	62	75	.95	−2.2	12	7.1	sw.	25	sw.	11	19	7	5	3.7	.0	.0
Concord	289	60	.....	29.75	30.06	+.08	72.7	+5.9	95	21	84	49	15	62	39	.....	.....	....	4.62	+1.1	12	.....	ne.	.....	.....	.....	14	8	9	.....	.0	.0
Burlington	403	11	48	29.61	30.03	+.06	72.0	+4.1	91	6	82	50	15	62	30	65	62	77	4.18	+.8	12	7.0	s.	22	s.	19	10	12	9	5.1	.0	.0
Northfield	876	12	60	29.14	30.06	+.08	69.2	+5.8	91	16	81	43	15	58	38	64	62	87	4.14	+.6	10	5.7	s.	21	sw.	11	5	16	10	6.2	.0	.0
Boston [1]	29	31	50	30.02	30.06	+.07	74.6	+4.7	98	20	83	57	23	66	27	68	65	80	4.97	+1.4	11	8.0	sw.	25	w.	10	8	11	12	5.8	.0	.0
Nantucket	12	14	90	30.06	30.07	+.08	71.8	+4.0	84	20	78	58	25	66	19	69	68	93	3.39	.0	8	12.5	sw.	38	ne.	22	10	7	14	6.0	.0	.0
Block Island	26	11	46	30.05	30.08	+.09	72.4	+3.9	84	7	78	59	23	67	16	69	69	93	5.85	+2.2	8	12.0	sw.	32	ne.	22	6	14	11	6.2	.0	.0
Providence	159	215	251	29.90	30.07	+.08	75.0	+4.0	97	20	84	55	23	67	26	68	66	79	4.13	+.6	11	8.7	sw.	30	nw.	27	11	9	11	5.5	.0	.0
Hartford	159	66	100	29.89	30.06	+.07	74.6	+5.7	96	20	84	56	23	65	29	.....	.....	....	7.14	+2.8	11	6.8	s.	29	sw.	11	11	11	9	5.2	.0	.0
New Haven	106	74	153	29.96	30.07	+.08	75.0	+4.7	95	20	83	57	23	67	25	69	66	80	7.00	+2.7	11	7.9	s.	27	sw.	11	9	10	12	5.7	.0	.0
Middle Atlantic States							**76.1**	**+2.7**										**80**	**6.07**	**+1.8**										**5.6**		
Albany	97	97	112	29.95	30.05	+.07	75.4	+4.6	97	20	85	56	15	66	30	68	65	77	4.16	+.4	11	6.1	s.	22	s.	11	8	12	11	5.4	.0	.0
Binghamton	871	57	79	29.16	30.07	+.08	74.0	+6.0	94	20	85	51	15	63	36	.....	.....	....	2.70	−.9	12	4.9	ne.	18	nw.	21	4	10	17	7.1	.0	.0
New York	314	415	454	29.74	30.06	+.06	75.7	+2.6	93	20	83	58	23	69	21	69	67	81	7.92	+3.6	17	10.3	sw.	49	sw.	11	12	7	12	5.5	.0	.0
Harrisburg	374	94	104	29.66	30.05	+.04	75.0	+2.4	93	20	83	59	23	67	27	69	66	78	6.24	+2.2	13	5.6	s.	21	sw.	10	11	7	13	5.4	.0	.0
Philadelphia	114	174	367	29.96	30.08	+.08	77.2	+2.4	94	19	85	60	23	70	23	70	67	77	4.10	−.5	12	10.8	sw.	44	sw.	11	10	8	13	5.5	.0	.0
Reading	323	283	306	29.72	30.06	.....	75.5	+3.1	96	20	84	57	23	68	25	68	66	77	5.23	+1.0	12	7.9	s.	35	w.	19	8	12	11	5.8	.0	.0
Scranton	805	72	104	29.22	30.07	+.07	74.0	+4.2	94	20	84	54	15	64	32	67	64	75	6.43	+2.7	14	4.9	n.	25	nw.	21	7	16	8	5.5	.0	.0
Atlantic City	52	37	172	30.01	30.06	+.06	74.0	+1.5	90	31	79	65	22	69	17	70	69	89	6.13	+1.6	14	13.3	s.	31	s.	11	10	12	9	5.2	.0	.0
Sandy Hook	22	10	57	30.04	30.06	.....	75.6	+3.1	92	21	82	61	23	69	23	70	69	86	7.88	+2.9	15	10.9	s.	37	s.	11	11	9	11	5.2	.0	.0
Trenton	190	88	106	29.86	30.06	.....	76.0	+3.0	95	21	85	58	23	67	27	69	67	80	5.12	+.4	13	7.9	s.	31	s.	11	11	7	13	5.7	.0	.0
Baltimore	123	100	215	29.93	30.06	+.05	78.4	+2.9	96	19	86	62	23	70	24	71	68	76	5.06	+.7	10	8.7	s.	46	nw.	12	11	8	12	5.5	.0	.0
Washington	112	62	85	29.94	30.05	+.04	77.8	+2.8	97	20	86	62	15	69	26	70	68	79	6.70	+2.7	11	5.5	sw.	22	w.	8	11	10	10	5.3	.0	.0
Cape Henry	18	8	54	30.06	30.08	.....	78.3	+1.4	94	7	85	63	17	71	22	73	72	85	4.51	−.4	10	8.5	sw.	28	s.	10	11	10	10	5.2	.0	.0
Lynchburg	686	148	184	29.36	30.10	+.08	76.4	+.8	93	18	86	59	15	67	29	69	67	83	4.89	+1.1	18	5.4	w.	30	n.	18	11	10	10	5.4	.0	.0
Norfolk	91	80	125	29.99	30.08	+.08	79.6	+2.2	94	9	87	66	17	72	22	73	71	82	6.77	+1.6	12	7.9	sw.	27	sw.	13	7	10	14	6.4	.0	.0
Richmond	144	11	52	29.93	30.08	+.07	77.6	+1.1	92	20	86	62	15	69	24	71	69	85	9.85	+5.4	14	6.4	sw.	32	sw.	10	12	6	13	5.6	.0	.0
Wytheville	2,304	49	55	.....	30.10	+.09	72.4	+1.9	90	18	83	52	1	62	32	.....	.....	....	9.54	+5.4	16	4.8	w.	21	nw.	12	6	13	12	.....	.0	.0
South Atlantic States							**79.4**	**+1.2**										**83**	**5.61**	**0.0**										**5.8**		
Asheville	2,253	89	104	27.79	30.08	+.06	74.4	+3.9	92	20	85	58	8	64	29	66	65	85	5.29	+1.1	17	5.6	s.	21	se.	23	5	15	11	6.2	.0	.0
Charlotte	779	63	86	29.26	30.08	+.06	79.0	+1.9	93	8	88	66	16	70	25	71	70	83	4.31	−.8	14	6.2	s.	20	sw.	22	6	8	17	6.7	.0	.0
Greensboro [1]	886	6	56	29.15	30.07	.....	77.4	.....	93	8	87	60	16	68	29	70	69	87	5.16	−.1	16	6.5	s.	28	nw.	9	7	14	10	6.0	.0	.0
Hatteras	11	5	50	30.09	30.10	+.10	79.5	+1.5	87	30	84	70	3	75	12	75	73	83	5.00	−.8	16	9.5	sw.	28	sw.	13	10	14	7	5.0	.0	.0
Raleigh	376	103	140	29.68	30.06	+.05	78.6	+1.6	92	8	88	62	16	70	26	72	70	85	5.65	+.2	18	7.0	sw.	27	w.	26	7	16	8	5.2	.0	.0
Wilmington	72	73	107	.....	30.08	+.08	79.4	+1.8	90	6	86	66	16	72	19	.....	.....	....	4.64	−1.7	18	7.4	s.	24	s.	10	7	19	5	.....	.0	.0
Charleston	48	11	92	30.03	30.08	+.07	81.0	.0	93	7	87	70	1	75	22	75	73	81	4.09	−2.4	11	9.2	s.	31	se.	30	6	15	10	6.0	.0	.0
Columbia, S. C.	347	70	91	29.71	30.08	+.07	79.4	−.2	93	5	88	65	17	71	25	72	70	80	6.30	+.8	17	6.9	s.	25	se.	28	10	9	12	5.3	.0	.0
Greenville, S. C.	1,039	139	.....	.....	.....	.....	78.0	+2.2	92	18	87	65	1	69	25	.....	.....	....	4.51	−1.0	9	.....	ne.	.....	.....	.....	7	6	18	.....	.0	.0
Augusta	182	62	77	29.86	30.05	+.04	80.8	+.4	95	8	90	65	17	72	25	73	71	81	4.21	−.8	16	5.1	s.	19	ne.	14	7	12	12	6.0	.0	.0
Savannah	65	73	152	29.99	30.06	+.05	81.4	+.7	93	7	89	67	1	74	23	75	73	84	7.33	.0	16	8.6	s.	32	se.	30	5	16	10	6.1	.0	.0
Jacksonville	43	86	110	30.00	30.05	+.04	81.4	−.3	95	7	89	69	17	74	22	75	73	84	10.78	+5.0	18	6.4	s.	25	e.	30	7	16	8	5.7	.0	.0
Florida Peninsula							**82.3**	**+0.4**										**80**	**6.16**	**−0.2**										**5.8**		
Key West	22	10	64	29.96	29.98	.00	83.8	+.3	93	29	90	71	4	78	21	77	75	78	4.34	−.2	15	8.2	e.	24	w.	17	12	12	7	4.9	.0	.0
Miami	25	124	168	29.99	30.02	.00	82.0	+.6	92	29	88	69	4	76	20	76	74	78	8.82	+2.6	20	8.1	e.	29	s.	14	7	14	10	6.3	.0	.0
Tampa	35	88	197	30.00	30.03	+.03	81.8	+.3	94	25	90	70	21	74	22	75	73	84	8.08	−.1	21	8.4	e.	35	se.	22	2	19	10	6.3	.0	.0
Titusville	43	5	36	29.97	30.02	.....	81.6	+.2	96	20	91	68	11	72	24	76	74	....	3.41	−3.1	11	.....	se.	.....	.....	.....	6	15	10	.....	.0	.0
East Gulf States							**81.0**	**+1.0**										**81**	**6.40**	**+1.1**										**6.4**		
Atlanta [1]	976	5	53	29.04	30.04	+.03	79.5	+2.5	95	5	89	66	1	70	28	71	69	84	5.50	+1.0	17	5.6	s.	29	sw.	21	3	16	12	6.8	.0	.0
Macon	370	79	87	29.66	30.05	+.04	80.2	+.3	93	25	90	64	7	71	26	72	70	79	3.17	−1.2	12	5.7	s.	29	nw.	7	5	14	12	6.2	.0	.0
Thomasville	273	49	58	29.76	30.05	+.05	80.3	−.7	94	8	90	65	1	71	26	74	73	....	5.20	−.6	13	.....	e.	.....	.....	.....	.....	.....	.....	.....	.0	.0
Apalachicola	35	11	.....	29.98	30.02	.....	81.0	−.2	91	20	87	70	24	75	15	76	74	81	8.59	+1.0	15	6.5	se.	28	s.	31	5	11	15	6.9	.0	.0
Pensacola	56	149	185	29.96	30.02	+.04	80.2	−.7	89	1	85	71	27	75	14	75	73	81	13.31	+5.3	17	9.0	s.	43	e.	1	2	17	12	6.2	.0	.0
Anniston	741	9	.....	.....	.....	.....	79.1	+2.7	94	4	89	64	19	69	27	.....	.....	....	10.19	+6.1	15	.....	sw.	.....	.....	.....	13	9	9	.....	.0	.0
Birmingham	700	11	48	29.27	30.02	+.03	81.0	+1.8	97	9	91	68	6	71	25	72	70	78	5.27	+1.0	15	5.6	se.	18	se.	9	9	12	10	5.6	.0	.0
Mobile	57	86	161	29.95	30.01	+.03	82.0	+1.0	96	1	89	71	18	75	22	75	73	83	4.45	−2.5	19	6.8	s.	36	e.	5	0	17	14	6.9	.0	.0
Montgomery	218	92	105	29.80	30.04	+.05	81.4	+.6	96	8	90	70	6	73	24	73	71	80	5.67	+1.4	16	6.0	se.	24	se.	23	9	13	9	5.5	.0	.0
Meridian	375	67	92	29.62	30.01	+.03	81.6	+2.1	100	10	92	68	18	72	28	73	70	80	3.86	−.7	15	4.9	e.	27	se.	10	5	12	14	6.5	.0	.0
Vicksburg	247	82	102	29.74	29.99	+.01	82.2	+1.4	96	4	91	71	7	74	23	74	72	80	3.65	+.2	13	6.7	sw.	24	e.	28	5	14	12	6.3	.0	.0
New Orleans	53	76	84	29.95	30.00	+.02	83.0	+.8	95	1	90	68	6	76	22	76	74	80	7.94	+2.1	15	5.4	se.	20	e.	10	2	20	9	6.6	.0	.0
Port Eads, La	9	4	35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
West Gulf States							**84.4**	**+2.5**										**72**	**2.56**	**−0.7**										**4.3**		
Shreveport	249	92	227	29.72	29.98	+.01	84.4	+2.4	104	10	94	69	6	74	26	75	72	74	3.02	+.3	9	8.2	se.	31	s.	21	13	13	5	4.4	.0	.0
Bentonville	1,303	12	38	29.59	29.92	−.05	80.4	+3.9	98	9	90	60	13	70	29	.....	.....	....	3.13	−.9	4	4.9	s.	21	n.	4	9	19	3	.....	.0	.0
Fort Smith	457	79	94	29.49	29.96	−.01	84.6	+4.1	107	10	95	68	13	74	30	73	69	68	1.27	−2.0	8	6.6	e.	19	ne.	4	9	16	6	5.1	.0	.0
Little Rock	357	94	102	29.62	29.98	.00	83.0	+3.2	106	10	92	69	6	74	30	73	70	72	4.68	+.9	12	6.4	sw.	21	sw.	9	11	12	8	5.0	.0	.0
Austin	605	68	90	29.32	29.94	.....	86.0	+2.2	102	4	97	70	24	75	27	73	68	63	4.26	+2.2	3	7.2	s.	22	s.	24	19	10	2	3.3	.0	.0
Brownsville	57	88	96	29.87	29.93	.....	84.6	+.7	95	4	92	71	29	77	21	76	74	81	1.55	−1.0	5	9.4	se.	24	ne.	29	15	15	1	3.7	.0	.0
Corpus Christi	20	11	78	29.92	29.94	+.01	84.6	+2.1	93	10	90	75	15	79	15	77	75	80	1.66	−.6	2	10.6	se.	29	se.	15	17	12	2	3.5	.0	.0
Dallas	512	220	227	29.41	29.94	.....	85.6	.....	103	10	95	70	23	76	30	72	67	62	2.93	+.2	6	9.6	se.	42	ne.	5	13	12	6	4.0	.0	.0
Fort Worth	679	92	110	29.26	29.95	+.01	86.6	+3.6	104	4	97	70	14	76	30	.....	.....	....	1.02	−1.6	7	8.5	s.	31	se.	14	19	11	1	3.0	.0	.0
Galveston	54	106	114	29.92	29.98	+.02	84.2	+1.2	92	27	88	72	15	80	13	77	75	78	3.24	−1.0	10	9.3	s.	21	se.	15	13	16	2	4.5	.0	.0
Houston	138	292	314	29.83	29.97	.....	84.0	+.8	100	10	93	72	15	76	24	.....	.....	....	4.18	.0	10	8.7	s.	30	se.	4	6	21	4	5.2	.0	.0
Palestine	510	64	72	29.46	29.98	+.01	84.6	+2.8	102	10	95	68	25	74	25	73	69	70	1.58	−.6	9	6.5	s.	22	ne.	11	11	17	3	4.5	.0	.0
Port Arthur	34	98	106	29.94	29.98	.....	83.2	.....	93	10	90	73	26	77	17	76	74	79	3.22	−2.8	9	8.4	s.	30	se.	19	5	19	7	5.5	.0	.0
San Antonio	693	242	301	29.23	29.92	−.01	86.0	+2.5	101	10	97	70	31	75	27	73	68	64	.14	−2.3	4	9.8	se.	35	se.	25	11	18	2	4.4	.0	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, August 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F. 78.0	°F. +3.0	°F.		°F.	°F		°F	°F.	°F.	°F.	% 74	*In.* 3.90	*In.* +0.4		*Miles*							*0–10* 4.8	*In.*	*In.*
Chattanooga	762	71	214	29.24	30.04	+0.04	80.4	+2.9	99	3	91	67	2	70	30	71	68	74	7.33	+3.3	13	5.2	se.	28	nw.	22	8	15	8	5.7	.0	.0
Knoxville	995	66	84	29.01	30.04	+.03	79.2	+3.0	95	4	89	64	2	70	28	71	69	79	5.70	+1.8	12	4.6	e.	18	nw.	12	16	7	8	4.4	.0	.0
Memphis	399	78	86	29.58	30.00	+.02	82.2	+2.8	98	10	90	71	12	75	22	74	70	71	1.72	−1.6	10	6.7	sw.	21	ne.	12	10	10	11	5.6	.0	.0
Nashville	546	168	188	29.46	30.04	+.04	81.0	+3.2	98	4	91	64	2	71	31	70	66	69	2.17	−1.5	11	6.5	sw.	26	ne.	9	9	16	6	5.0	.0	.0
Lexington	989	6					78.5	+4.0	98	3	90	58	1	67	33				3.52	+.1	8		n.				14	10	7		.0	.0
Louisville	525	188	234	29.48	30.05	+.05	79.2	+2.2	94	3	88	64	14	70	25	70	67	72	4.27	+.8	10	7.6	n.	35	sw.	8	18	5	8	4.2	.0	.0
Evansville	431	76	116	29.56	30.02	+.03	81.0	+3.6	96	16	91	65	5	71	26	70	66	68	3.45	+.1	6	6.4	e.	25	w.	7	14	11	6	4.4	.0	.0
Indianapolis	822	194	230	29.18	30.05	+.05	77.0	+3.3	94	17	87	60	13	67	27	68	64	70	3.46	+.2	8	8.1	e.	53	w.	11	15	10	6	4.2	.0	.0
Terre Haute	575	63	149	29.41	30.01		79.5		97	17	90	60	13	68	30	70	66	71	3.10	−.2	8	7.0	sw.	32	nw.	11	21	5	5	3.1	.0	.0
Cincinnati	627	11	51	29.39	30.05	+.04	76.8	+3.2	94	17	87	60	3	67	32	69	66	78	3.30	−.1	10	5.3	ne.	33	w.	12	14	6	11	4.8	.0	.0
Columbus	822	90	210	29.19	30.05	+.04	76.6	+3.6	94	20	86	60	2	67	26	68	64	72	2.89	−.4	10	6.9	s.	33	w.	8	14	12	5	4.3	.0	.0
Dayton	899	60	163	29.11	30.04		76.5	+3.1	94	17	86	61	14	67	28				4.92	+1.6	9	6.0	sw.	24	nw.	8	14	8	9	4.3	.0	.0
Elkins	1,947	59	78	28.10	30.09	+.07	71.2	+2.1	90	20	82	52	3	60	35	65	63	86	6.61	+2.8	15	3.8	w.	25	nw.	6	7	9	15	6.4	.0	.0
Parkersburg	637	77	84	29.38	30.03	+.02	76.8	+2.9	94	19	86	60	14	67	33	69	66	76	3.58	+.1	8	4.6	se.	20	nw.	21	12	6	13	5.5	.0	.0
Pittsburgh [1]	1,279	39	54	28.74	30.06	+.05	75.2	+2.3	93	20	85	59	2	66	30	67	64	76	2.52	−.7	13	7.7	s.	26	n.	21	8	13	10	5.9	.0	.0
Lower Lake Region							74.1	+4.4										76	3.72	+0.7									5.0		
Buffalo	768	243	280	29.24	30.05	+.06	73.3	+4.7	88	30	80	59	22	67	21	67	64	77	2.08	−1.0	8	9.8	sw.	40	sw.	12	10	11	10	5.3	.0	.0
Canton	448	10	61	29.56	30.03		71.9	+4.1	93	6	83	47	23	61	33	66	63	80	5.04	+1.4	12	6.3	sw.	25	w.	19	8	12	11	5.4	.0	.0
Ithaca	836	77	100	29.17	30.06		73.5	+4.9	94	20	85	50	15	62	38	66	64	78	8.14	+4.8	11	6.1	se.	25	s.	12	6	11	14	6.4	.0	.0
Oswego	335	71	85	29.68	30.04	+.05	72.8	+4.4	90	20	81	53	15	65	31	67	64	77	3.04	+.4	5	6.5	s.	22	sw.	12	11	9	11	5.9	.0	.0
Rochester	523	86	102	29.50	30.06	+.07	74.2	+5.0	91	20	83	57	15	66	29	66	63	73	4.71	+1.8	8	6.4	sw.	23	sw.	19	14	10	7	4.5	.0	.0
Syracuse	596	65	79	29.43	30.06	+.07	75.4	+6.6	94	6	84	56	15	66	31				5.83	+3.0	11	5.6	s.	18	w.	12	9	10	12	5.8	.0	.0
Erie	714	130	166	29.30	29.05	+.04	74.3	+4.7	92	19	82	59	15	67	26	67	64	75	4.45	+1.2	11	9.2	n.	30	sw.	19	14	10	7	4.6	.0	.0
Cleveland	762	267	318	29.25	30.09	+.05	74.4	+4.4	93	20	80	63	25	68	22	67	64	74	2.10	−.7	6	10.3	ne.	29	ne.	22	14	10	7	4.1	.0	.0
Sandusky	629	5	67	29.38	30.06	+.05	75.4	+3.6	96	20	84	60	2	67	28				3.03	−.1	11	6.5	ne.	25	sw.	11	13	10	8	4.5	.0	.0
Toledo	628	79	87	29.40	30.07	+.07	74.8	+3.5	93	17	84	58	1	66	25	67	64	76	2.78	−.1	8	7.0	e.	25	sw.	8	15	8	8	4.3	.0	.0
Fort Wayne	857	69	84	29.15	30.06		75.1	+3.4	92	17	85	59	1	66	24	67	63	71	.96	−2.2	8	6.5	ne.	27	w.	8	13	11	7	4.6	.0	.0
Detroit [1]	626	5	78	29.38	30.05	+.04	74.0	+3.7	92	19	84	53	23	64	27	67	64	74	2.51	−.3	9	6.6	ne.	25	sw.	19	16	6	9	4.3	.0	.0
Upper Lake Region							72.0	+5.7										74	2.42	−0.5									4.5		
Alpena	609	13	89	29.40	30.06	+.06	70.4	+6.3	94	15	79	49	23	62	28	64	62	79	3.31	+.4	8	8.2	se.	25	se.	14	13	8	10	5.1	.0	.0
Escanaba	612	44	49	29.38	30.03	+.04	68.4	+4.1	88	4	78	47	21	59	29	62	59	76	1.17	−2.0	6	7.3	s.	24	ne.	11	12	11	7	4.6	.0	.0
Grand Rapids	707	70	244	29.30	30.05	+.05	76.0	+6.3	94	31	86	53	22	66	28	66	62	69	4.11	+1.5	11	7.3	sw.	24	sw.	11	12	11	8	4.5	.0	.0
Lansing	878	5	90	29.13	30.05		71.8	+3.3	89	31	82	50	1	62	26	66	64	82	4.42	+1.6	10	6.1	s.	20	n.	10	16	10	5	4.0	.0	.0
Ludington	637	5	54	29.35	30.04		71.2	+5.9	87	10	80	49	22	63	25	64	61		1.47	−1.2	4		s.				19	9	3		.0	.0
Marquette	734	44	69	29.21	30.00	+.02	70.3	+6.5	94	15	81	41	22	60	32	62	58	70	1.13	−1.5	8	7.8	s.	26	sw.	15	8	18	5	5.3	.0	.0
Sault Sainte Marie	614	11	52	29.37	30.05	+.06	68.8	+6.7	89	29	80	45	22	58	30	61	58	74	1.08	−1.5	7	5.7	se.	20	nw.	12	15	12	4	4.1	.0	.0
Chicago	673	7	131	29.33	30.04	+.04	75.7	+4.1	95	16	84	62	13	68	28	68	65	75	2.68	−.5	8	7.9	s.	35	w.	11	14	10	7	4.0	.0	.0
Green Bay	617	109	141	29.36	30.01	+.02	74.7	+7.0	98	16	86	49	22	64	29	65	60	67	2.62	−.6	5	9.3	s.	29	sw.	11	15	6	10	4.4	.0	.0
Milwaukee	681	97	221	29.30	30.03	+.03	74.8	+5.6	98	16	82	58	1	68	27	66	63	70	.80	−1.9	6	10.5	sw.	30	nw.	11	15	9	7	4.3	.0	.0
Duluth	1,133	5	47	28.76	29.95	−.02	69.7	+7.1	93	26	79	51	21	60	30	62	59	76	3.87	+.7	8	9.8	ne.	29	nw.	16	11	14	6	4.7	.0	.0
North Dakota							73.3	+7.4										55	2.03	−0.2									3.7		
Moorhead, Minn	940	50	58	28.90	29.90	−.06	74.2	+8.1	98	1	86	50	20	62	38	65	60	68	3.59	+.7	11	8.6	s.	26	sw.	24	11	15	5	4.9	.0	.0
Bismarck	1,674	8	57	28.13	29.86	−.08	75.4	+8.1	104	6	89	52	20	62	43	61	51	49	1.12	−.7	4	8.8	se.	38	sw.	14	14	11	6	4.2	.0	.0
Devils Lake	1,478	11	44	28.35	29.89	−.05	72.0	+7.2	100	6	86	47	20	58	45	60	54	61	1.25	−1.2	10	8.6	se.	28	ne.	14	16	10	5	3.5	.0	.0
Grand Forks	833	12	67				71.7	+6.3	96	14	84	44	21	59	40	63			3.22	+.6	6		se.	38	s.	1	11	17	3		.0	.0
Williston	1,878	42	50	27.94	29.86	−.07	73.4	+7.3	103	23	87	48	20	60	46	57	45	43	.98	−.5	3	7.9	se.	46	w.	1	23	8	0	2.1	.0	.0
Upper Mississippi Valley							78.5	+5.7										68	2.18	−1.1									4.2		
Mpls.-St. Paul, Minn	919	105	208	29.00	29.96	−.01	77.7	+7.8	97	5	87	55	21	68	26	67	62	61	4.10	+1.0	9	9.8	s.	34	n.	6	12	11	8	4.7	0.0	0.0
La Crosse	714	11	48	29.23	29.98	.00	76.8	+6.8	100	16	87	55	22	67	28	68	64	72	3.97	+.3	7	4.7	s.	14	s.	15	16	11	4	3.5	.0	.0
Madison	974	70	78	28.99	30.00	+.01	75.7	+5.9	98	16	86	53	22	66	27	66	61	66	.67	−2.5	5	6.6	s.	19	s.	15	12	10	9	4.9	.0	.0
Charles City	1,015	10	51	28.94	30.00	+.03	76.4	+7.3	101	16	87	56	12	65	31	67	64	71	2.85	−.6	11	6.1	se.	20	s.	15	13	12	6	4.2	.0	.0
Davenport	606	66	161	29.37	30.02	+.04	79.1	+6.0	99	16	88	55	22	70	26	68	64	66	1.91	−1.6	8	7.5	s.	19	sw.	7	15	10	6	4.2	.0	.0
Des Moines	861	5	99	29.09	29.98	−.01	78.8	+5.7	101	16	89	60	21	68	30	70	66	70	2.72	−.8	11	7.9	se.	25	nw.	6	19	8	4	3.2	.0	.0
Dubuque	699	60	79	29.27	30.01	+.03	77.1	+5.4	100	16	88	53	22	66	33	67	63	67	1.63	−1.6	6	4.9	s.	21	se.	15	18	6	7	3.7	.0	.0
Keokuk	614	64	78	29.35	30.00	+.02	78.8	+3.8	98	16	88	64	22	69	27	70	66	71	3.88	+.7	8	5.8	se.	26	se.	18	13	8	10	4.9	.0	.0
Cairo	358	87	93	29.62	29.99	.00	82.0	+4.2	97	9	91	67	14	73	26	72	69	72	.42	−2.6	6	6.1	ne.	18	nw.	17	8	14	9	5.5	.0	.0
Peoria	609	11	45	29.38	30.04	+.05	78.3	+5.8	99	16	89	56	13	67	32	69	66	73	1.55	−1.6	9	4.8	s.	15	w.	20	17	10	4	3.2	.0	.0
Springfield, Ill	636	5	191	29.35	30.01	+.02	79.5	+5.0	98	16	90	64	13	69	31	69	66	70	.94	−2.2	8	8.8	se.	38	nw.	11	13	10	8	4.6	.0	.0
St. Louis	568	179	303	29.40	30.00	+.01	82.3	+4.8	97	11	91	68	5	73	23	70	66	62	1.57	−1.4	8	9.2	s.	30	sw.	17	19	8	4	3.6	.0	.0
Missouri Valley							81.6	+7.6										62	2.59	−0.8									3.7		
Columbia, Mo	784	6	66	29.17	29.98	+.01	81.2	+5.6	98	17	92	62	13	71	27				1.98	−1.6	7	6.7	se.	28	n.	3	13	12	6	4.7	.0	.0
Kansas City [1]	750	32	45	29.17	29.95	−.02	83.8	+7.2	104	3	94	66	22	73	27	71	66	63	2.26	−1.8	5	8.0	s.	33	nw.	3	13	14	4	4.4	.0	.0
St. Joseph	967	11	49	28.95	29.95		82.5		102	15	93	64	22	72	28	71	66	65	3.24	−.6	6	7.4	se.	23	w.	10	23	6	2	2.5	.0	.0
Springfield, Mo	1,324	98	104	28.62	29.99	+.02	80.3	+4.6	98	10	89	63	13	71	25	70	66	68	1.88	−2.2	7	8.0	se.	26	e.	4	11	17	3	4.3	.0	.0
Topeka	987	65	87	28.92	29.94		84.3	+8.1	106	3	96	63	22	72	32	71	66	62	3.35	−.7	9	8.6	s.	27	nw.	10	12	15	4	4.0	.0	.0
Lincoln	1,189	11	81	28.68	29.90	−.05	84.3	+9.9	106	15	96	59	21	72	32	70	62	55	1.69	−1.9	7	9.4	s.	32	nw.	11	17	13	1	3.4	.0	.0
Omaha [1]	982	31	44	28.91	29.93	−.03	81.6	+7.2	103	15	93	59	21	70	31	71	66	65	.97	−2.1	6	10.3	se.	41	nw.	11	20	11	0	3.1	.0	.0
Valentine	2,598	47	54	27.28	29.93	−.01	78.6	+6.9	108	15	93	55	30	65	42	63	55	54	2.46	+.3	9	9.8	s.	43	sw.	1	17	10	4	3.6	.0	.0
Sioux City	1,138	64	106	28.74	29.91	−.04	80.4	+8.4	106	16	92	58	12	69	35	70	65	65	7.09	+4.0	11	9.2	s.	53	nw.	5	16	11	4	3.7	.0	.0
Huron	1,307	59	74	28.54	29.90	−.05	79.5	+10.1	109	15	92	53	21	66	41	66	59	60	.94	−1.5	5	10.2	se.	42	w.	19	22	6	3	3.0	.0	.0
Northern Slope							69.7	+3.6										44	0.62	−0.6									3.5		
Missoula	3,263	80	91				66.5	+.9	93	22	82	38	29	51	44				.33	−.6	6	7.0	nw.	31	nw.	14	16	12	3	3.3	.0	.0
Havre	2,507	11	67	27.31	29.90	−.01	67.5	+2.1	98	22	84	37	29	51	48	52	38	43	.82	−.4	4	8.1	w.	31	sw.	23	17	11	3	3.1	.0	.0
Helena	4,124	85	111	25.83	29.93	−.01	66.8	+1.8	92	26	80	39	29	54	38	51	37	37	.65	−.1	3	8.7	sw.	32	sw.	5	14	16	1	3.4	.0	.0
Kalispell	2,973	48	56	26.95	29.96	−.03	62.0	−.8	87	17	76	36	29	48	41	50	40	51	.66	−.2	7	6.1	w.	21	sw.	23	12	14	5	4.6	.0	.0
Miles City	2,371	48	55	27.41	29.84	−.09	75.0	+3.5	104	13	90	49	20	60	47	56	42	37	1.33	+.2	2	5.9	ne.	43	w.	1	20	6	5	3.3	.0	.0
Rapid City	3,259	50	58	26.61	29.87	−.06	76.7	+7.2	102	14	91	52	20	63	38	60	48	42	.43	−1.3		38.0	w.	36	nw.	9	18	10	3	3.3	.0	.0
Cheyenne [1]	6,144	5	39	24.07	29.94	+.02	71.1	+5.5	94	14	87	48	20	55	42	54	43	48	1.34	−.2	7	9.4	nw.	38	sw.	9	11	16	4	4.3	.0	.0
Lander	5,372	60	68	24.72	29.92	.00	70.0	+4.5	95	13	87	43	30	53	42	53	39	39	.12	−.4	3	6.1	sw.	32	w.	22	18	8	5	3.8	.0	.0
Sheridan	3,790	10	47	26 10	29.92		70.6		101	13	90	41	30	52	51	54	44	48	.03	−.9	2	4.8	nw.	22	sw.	22	19	10	2	3.2	.0	.0
Yellowstone Park	6,241	12	46	23.98	30.01	+.08	62.0	+2.9	86	13	77	35	2	47	38	47	34	42	.35	−.9	3	8.8	sw.	30	sw.	23	19	10	2	3.2	.0	.0
North Platte	2,821	11	51	27.06	29.90	−.04	79.6	+8.8	105	15	94	57	6	66	39	65	59	58	.76	−1.6	7	7.4	s.	32	ne.	3	21	8	2	3.0	.0	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, August 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–1	In.	In.
Middle Slope				82.2				+6.2										51	1.59	−0.9										3.8		
Denver	5,292	106	113	24.82	29.94	+0.02	76.8	+6.1	97	14	90	56	30	64	33	57	45	41	.63	−.8	8	7.6	s.	28	nw.	5	12	17	2	4.1	0.0	0.0
Pueblo	4,685	80	86	25.35	29.90	−.01	78.5	+5.8	99	14	92	54	22	65	40	59	47	42	1.02	−.8	5	7.8	nw.	30	nw.	13	16	14	1	3.8	.0	.0
Concordia	1,392	50	58	28.48	29.91	−.04	84.0	+7.5	107	9	96	61	23	72	37	69	61	53	1.98	−.9	7	8.5	s.	29	nw.	3	15	14	2	3.4	.0	.0
Dodge City	2,509	10	86	27.38	29.90	−.03	83.8	+6.1	107	10	96	61	22	71	39	67	59	51	.60	−2.1	6	12.2	sw.	35	se.	10	16	13	2	3.5	.0	.0
Wichita	1,358	85	93	28.54	29.92	−.03	84.0	+5.7	105	10	94	66	23	74	35	70	65	59	2.88	−.3	7	10.3	se.	37	ne.	6	19	8	4	3.3	.0	.0
Oklahoma City	1,214	10	47	28.68	29.93	−.01	85.8	+6.1	107	10	97	68	20	75	30	71	65	61	2.44	−.4	8	8.5	s.	24	nw.	20	11	14	6	5.0	.0	.0
Southern Slope				84.1				+4.5										50	1.08	−1.2										3.6		
Abilene	1,738	10	52	28.16	29.91	−.01	86.8	+4.8	105	4	99	70	31	75	29	70	62	52	3.34	+1.1	7	8.7	se.	25	sw.	31	16	10	5	3.8	.0	.0
Amarillo	3,676	10	49	26.30	29.91	−.01	82.1	+6.4	103	10	94	65	21	70	32	65	56	48	.64	−2.4	7	9.1	s.	25	se.	19	11	15	5	4.5	.0	.0
Del Rio	960	63	71	28.89	29.84	−.06	87.8	+3.6	102	6	98	75	27	78	26	71	64	52	.03	−1.7	1	10.3	se.	29	e.	15	17	12	2	3.5	.0	.0
Roswell	3,566	75	85	26.39	29.90	+.02	79.8	+3.2	101	8	93	62	23	67	34	64	54	49	.33	−1.8	3	7.2	s.	26	e.	12	22	9	0	2.5	.0	.0
Southern Plateau				80.5				+3.6										46	0.61	−0.3										3.6		
El Paso	3,778	82	101	26.18	29.84	.00	84.3	+5.1	103	11	96	67	22	73	28	64	53	41	.36	−1.3	6	7.5	e.	26	se.	16	20	11	0	2.3	.0	.0
Albuquerque [1]	4,972	5	39	25.11	29.86	.....	77.8	+3.9	100	10	93	58	22	62	37	60	51	48	.22	−1.0	7	7.9	se.	30	sw.	12	10	21	0	4.3	.0	.0
Santa Fe	7,013	38	53	23.38	29.92	+.03	71.2	+3.8	91	10	84	53	21	58	31	55	46	47	1.11	−1.2	11	5.5	e.	22	se.	4	8	18	5	5.0	.0	.0
Flagstaff	6,907	10	59	23.48	29.89	+.05	66.5	+3.7	91	12	91	42	21	42	45	53	.....	58	2.51	−.2	13	7.1	n.	30	n.	27	2	21	8	6.0	.0	.0
Phoenix	1,107	39	51	28.66	29.77	−.02	92.2	+3.7	111	31	05	72	3	80	39	70	59	38	.05	−.9	2	6.1	w.	32	se.	16	19	10	2	2.7	.0	.0
Yuma	141	9	54	29.62	29.76	.00	93.4	+3.0	113	41	08	69	1	79	41	73	63	42	T	−.5	0	6.1	s.	20	s.	19	28	3	0	1.0	.0	.0
Independence	3,957	5	26	25.95	29.89	+.08	77.8	+1.7	104	12	97	48	31	59	44	54	32	.....	.00	−.1	0	.....	s.	.....	.....	.....	29	2	0	.....	.0	.0
Middle Plateau				73.0				+2.4										33	0.42	−0.3										2.2		
Reno	4,527	61	76	25.49	29.93	+.09	71.1	+2.4	99	12	88	45	29	54	40	52	36	33	.00	−.2	0	6.6	sw.	21	w.	9	27	3	1	1.2	.0	.0
Tonopah	6,090	12	20	.....	.....	.....	75.5	.....	93	12	87	50	1	64	29	52	32	22	.02	.....	1	.....	se.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Winnemucca	4,344	18	56	25.63	29.93	+.05	70.9	+1.6	101	12	91	38	30	50	52	49	30	27	.00	−.2	0	7.4	sw.	23	sw.	22	27	4	0	1.2	.0	.0
Modena	5,473	10	43	24.67	29.87	+.01	72.2	+3.0	96	12	89	47	2	55	45	54	40	38	.70	−.6	5	10.2	sw.	35	s.	30	21	10	0	2.4	.0	.0
Salt Lake City [1]	4,227	32	46	25.73	29.86	−.05	76.4	.....	102	13	92	51	2	61	44	57	42	35	.48	.....	6	10.4	se.	42	w.	14	20	6	5	2.7	.0	.0
Grand Junction	4,602	60	68	25.42	29.92	+.02	78.0	+2.6	98	9	92	57	20	64	38	59	47	41	1.00	−.2	9	7.1	se.	27	s.	30	16	13	2	3.4	.0	.0
Northern Plateau				69.1				−0.3										40	0.26	−0.2										2.3		
Baker	3,471	36	54	26.48	30.02	+.07	64.9	+.3	94	12	82	35	29	47	47	50	39	44	.11	−.4	3	5.9	n.	21	s.	22	23	7	1	1.9	.0	.0
Boise	2,739	79	87	27.14	29.94	+.01	71.2	−.6	97	12	87	42	29	55	38	54	38	35	.00	−.2	0	5.3	nw.	15	nw.	28	27	4	0	1.2	.0	.0
Pocatello	4,477	60	68	25.50	29.90	−.02	72.0	+2.4	98	13	87	45	3	57	45	52	35	30	.35	−.4	5	8.9	se.	38	sw.	13	23	6	2	2.4	.0	.0
Spokane	1,929	101	110	27.96	29.97	+.02	66.2	−1.9	93	12	79	41	29	53	42	52	39	44	.61	.0	6	6.7	s.	22	sw.	13	19	4	8	3.5	.0	.0
Walla Walla	991	57	65	28.93	29.98	+.02	71.8	−.9	99	4	84	47	29	60	36	55	41	37	.15	−.3	3	6.0	w.	19	w.	22	22	5	4	2.5	.0	.0
Yakima	1,076	58	67	28.85	29.99	.....	68.6	−.9	98	4	82	47	24	55	43	53	44	47	.33	+.2	5	6.1	nw.	25	nw.	13	22	5	4	2.4	.0	.0
North Pacific Coast Region				63.8				+0.2										70	1.48	+0.6										4.5		
North Head	211	11	56	29.88	30.10	+.07	58.6	+1.0	66	31	62	51	3	55	11	56	55	89	2.02	+1.0	14	12.1	nw.	34	se.	10	13	5	13	5.8	.0	.0
Seattle	125	90	321	29.92	30.05	+.05	64.4	+1.3	84	3	73	49	29	56	27	57	52	69	1.23	+.5	7	8.2	n.	33	sw.	13	10	11	10	5.6	.0	.0
Tatoosh Island	86	10	54	29.99	30.08	+.08	56.0	+.7	65	11	60	48	3	52	13	54	52	88	4.05	+2.0	16	8.9	s.	32	s.	21	4	7	20	7.3	.0	.0
Medford [1]	1,329	29	58	28.60	29.98	.....	69.6	−1.5	100	11	88	41	29	52	47	56	46	51	.04	−.2	2	.....	nw.	.....	.....	.....	24	6	1	1.5	.0	.0
Portland, Oreg.	153	68	106	29.89	30.05	+.04	66.8	+.1	92	3	77	48	28	57	33	59	53	65	1.41	+.8	6	6.4	nw.	15	s.	22	13	9	9	4.5	.0	.0
Roseburg	510	45	76	29.49	30.04	+.04	67.6	−.3	98	3	83	44	1	52	48	57	49	60	.14	−.2	3	5.0	n.	16	n.	28	22	4	5	2.5	.0	.0
Middle Pacific Coast Region				68.7				+1.6										60	0.01	0.0										2.0		
Eureka	62	73	89	29.99	30.06	+.06	56.4	+.4	67	22	61	48	29	51	14	53	51	84	.05	−.1	2	6.1	nw.	23	n.	23	13	13	5	4.3	.0	.0
Redding [1]	722	20	34	.....	.....	.....	82.6	+2.1	109	11	96	59	31	69	33	59	39	25	.00	.0	0	8.8	nw.	22	nw.	28	29	2	0	.3	.0	.0
Sacramento	66	92	115	29.79	29.87	+.02	77.0	+4.1	107	11	94	52	1	60	43	61	49	45	.00	.0	0	7.0	s.	18	s.	30	30	1	0	.3	.0	.0
San Francisco	155	112	132	29.76	29.93	+.01	58.9	−.2	79	11	65	50	26	53	22	55	53	84	T	.0	0	10.7	w.	26	w.	22	19	11	1	3.2	.0	.0
South Pacific Coast Region				74.2				+0.7										64	0.00	0.0										2.5		
Fresno	327	97	105	29.51	29.85	+.03	82.3	+1.6	106	12	98	57	29	66	37	62	47	35	.00	.0	0	6.4	nw.	16	nw.	22	31	0	0	.4	.0	.0
Los Angeles	338	159	191	29.55	29.90	+.02	71.6	+.5	95	27	81	60	8	62	30	64	60	75	.00	.0	0	5.3	sw.	14	w.	26	20	11	0	2.7	.0	.0
San Diego	87	62	70	29.81	29.90	+.01	68.8	+.1	79	27	73	61	10	64	14	64	62	82	.00	.0	0	6.6	nw.	18	w.	2	15	12	4	4.4	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.90	29.98	.....	80.8	+.3	90	25	85	73	9	76	15	.....	.....	.....	6.18	+.2	24	10.7	e.	34	e.	9	3	23	5	5.0	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	.....	[3] 29.82	−.01	80.8	−.4	91	7	87	71	9	74	17	.....	.....	[3] 85	3.80	−3.9	16	5.6	nw.	24	s.	26	0	23	8	7.0	.0	.0
Cristobal	36	6	97	.....	[3] 29.84	.00	81.8	+1.6	90	30	86	74	20	77	14	77	76	[3] 84	13.26	+1.9	27	7.3	w.	26	sw.	19	0	6	25	8.5	.0	.0
Alaska																																
Fairbanks	454	11	87	[3] 29.33	[3] 29.84	.....	52.0	−3.2	75	13	61	33	26	43	35	47	42	73	3.83	+1.8	19	6.3	s.	22	sw.	31	3	4	24	8.2	.0	.0
Juneau	80	96	116	[3] 29.84	[3] 29.92	.....	54.6	−.7	75	14	60	44	13	49	26	51	47	81	11.63	+4.4	26	6.7	s.	28	se.	2	6	2	23	7.8	.0	.0
Nome	22	5	32	[3] 29.82	[3] 29.84	.....	49.2	−.5	70	10	56	32	9	42	30	47	45	80	2.98	−.4	20	9.9	sw.	26	n.	2	5	8	18	7.2	.0	.0
Hawaiian Islands																																
Honolulu	38	86	100	[3] 29.97	[3] 30.01	.....	77.6	−.8	84	16	82	71	20	74	12	71	68	73	.98	−.3	15	10.5	e.	31	e.	23	4	20	7	5.7	.0	.0

[1] Observations taken at airport. [3] Observations taken hourly. [3] Pressure not reduced to mean of 24 hours.

TABLE 3.—*Data furnished by the Canadian Meteorological Service, August 1937*

Stations	Altitude above mean sea level Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Mean station pressure	Mean sea-level pressure	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99												
Sydney, Cape Breton Island	48	29.97	30.02	+0.04	69.8	+6.1	79.7	59.9	92	47	4.62	+0.92	0.0
Halifax, Nova Scotia	88	29.82	30.08	+.09	69.0	+4.5	77.0	60.9	90	52	2.86	−1.57	.0
Yarmouth, Nova Scotia	65	29.98	30.08	+.08	64.7	+4.1	71.8	57.6	81	48	3.53	+.03	.0
Charlottetown, Prince Edward Island	38	29.96	30.04	+.08	70.4	+6.0	78.8	61.9	88	50	2.11	−1.06	.0
Chatham, New Brunswick	28	29.90	30.00	+.05	69.6	+5.1	81.0	58.3	92	41	5.77	+1.70	.0
Father Point, Quebec	20												
Quebec, Quebec	296												
Doucet, Quebec	1,236	28.70	30.04	+.05	62.8	+5.8	76.7	48.9	92	30	3.25	−.25	.0
Montreal, Quebec	187	29.84	30.04	+.08	72.4	+5.6	79.3	65.0	87	52	3.51	+.05	.0
Ottawa, Ontario	236												
Kingston, Ontario	285	29.74	30.05	+.07	71.4	+4.8	78.2	64.6	89	54	5.21	+2.46	.0
Toronto, Ontario	379	29.65	30.06	+.07	72.5	+5.5	81.8	63.2	89	53	2.89	+.09	.0
Cochrane, Ontario	930	29.02	29.98	+.02	65.3	+5.3	76.9	53.7	91	34	1.86	−1.44	.0
White River, Ontario	1,244	28.70	30.02	+.06	62.6	+4.9	77.1	48.2	91	26	2.82	−.13	.0
London, Ontario	808	29.20	30.06	+.09	70.4	+4.0	81.0	59.9	88	48	4.31	+1.47	.0
Southampton, Ontario	656	29.36	30.06	+.06	68.8	+4.0	77.6	59.9	88	47	3.42	+1.12	.0
Parry Sound, Ontario	688	29.39	30.07	+.09	70.5	+6.3	79.9	61.0	87	47	2.42	−.34	.0
Port Arthur, Ontario	644	29.28	29.99	+.02	62.1	+1.7	72.9	51.3	87	34	5.41	+2.62	.0
Winnipeg, Manitoba	760	29.07	29.88	−.08	69.4	+5.4	81.7	57.0	97	45	2.12	−.22	.0
Minnedosa, Manitoba	1,690	28.11	29.88	−.05	65.1	+4.5	78.8	51.4	97	40	2.34	+.21	.0
Le Pas, Manitoba	860	28.90	29.86	−.05	63.1	+2.5	74.6	51.6	86	38	2.64	+.56	.0
Qu'Appelle, Saskatchewan	2,115	27.64	29.88	−.06	65.8	+4.0	81.3	50.3	100	35	.68	−1.25	.0
Moose Jaw, Saskatchewan	1,759	27.92	29.87	−.01	67.7	+4.4	82.6	52.8	98	37	.91	−.77	.0
Swift Current, Saskatchewan	2,392	27.40	29.91	−.01	66.0	+2.7	80.3	51.6	96	36	.83	−1.01	.0
Medicine Hat, Alberta	2,365	27.43	29.88	−.02	65.9	−.8	80.2	51.6	94	39	.79	−.63	.0
Calgary, Alberta	3,540												
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450	28.34	29.86	−.07	63.3	+3.2	76.9	49.7	96	37	.46	−1.78	.0
Battleford, Saskatchewan	1,592	28.16	29.88	−.05	60.7	+.2	77.2	44.2	95	32	.44	−1.46	.0
Edmonton, Alberta	2,150	27.62	29.88	−.01	58.1	−1.3	69.7	46.5	86	35	1.56	−.84	.0
Kamloops, British Columbia	1,262												
Victoria, British Columbia	230	29.80	30.04	+.02	59.4	−.5	67.1	51.6	79	48	1.55	+.94	.0
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20	30.06	30.08	+.04	56.4	−.4	61.8	51.0	67	43	5.81	+2.53	.0
Prince Rupert, British Columbia	170	29.81	30.00	−.03	55.7	−1.9	61.8	49.6	74	44	8.52	+3.32	.0
St. George's, Bermuda	158		30.18	+.08	83.9	+4.3	91.0	76.7	94	68	3.83	−2.13	.0
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Calgary, Alberta	3,540	26.35	29.97	+0.05	62.6	+1.9	74.7	50.6	90	41	3.18	+0.58	0.0
Estevan Point, British Columbia	20	30.11	30.13	+.05	57.0	+1.6	62.7	51.4	69	44	.86	−2.06	.0

TABLE 4.—*Severe local storms, August 1937*

(Compiled by Mary O. Souder from reports submitted by Weather Bureau officials)

The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Poplar, Mont., vicinity of	1	2:45 – 3:10 p. m.	[1] 4		$45,000	Hail	Damage to irrigated crops and gardens and tangible property.
Walworth and Potter Counties, S. Dak.	1	3–4 p. m.	[1] 16		75,000	Wind	Buildings, machinery, and other property damaged; corn blown down; 2 persons injured.
Miles City, Mont	1	3:55 – 5 p. m.			45,000	Wind and hail	Greatest damage in main section of the city to trees and shrubbery; considerable hail damage to crops and gardens.
Carlisle and Palmyra, Iowa	1	4:30 – 8:30 a. m.				Heavy rain	About 50 automobiles stalled on the highway; bridges and portion of the Rock Island Railroad track washed out; several farms flooded.
Greensville and Patrick Counties, Va.	2	1–3 p. m.			100,000	Heavy hail	Principal loss to crops; some damage to roofs.
Castlewood, S. Dak., vicinity of	2	7:50 p. m.	880		2,075	Wind	Buildings damaged; stock killed.
Edgecomb, Wilson, and Greene Counties, [2] N. C.	2	P. m.			100,000	Rain and hail	Chief loss in tobacco.
Box Butte County, Nebr.	3	1 p. m.	[1] 2		20,000	Hail	Property destroyed.
Caldwell, Kans., vicinity of	3	3 p. m.	67	0	500	Tornado	Freight cars turned over; farm buildings and telephone lines damaged; path 880 yards wide.
Osage County, Kans.	3	6 – 6:35 p. m.	[1] 2		3,500	Wind	Several barns and small farm buildings blown down and residences damaged; path 6 miles long.
Lincoln to Furnas Counties, Nebr., western sections.	3	6:30–7:30 p. m.	[1] 10		100,000	Hail and wind	Property destroyed.
Phillips, Smith, and Osborn Counties, Kans.	3	9 p. m.				Wind	Damage to farm buildings and telephone lines; path 60 miles long.
Hawley and Glyndon, Minn., and vicinities.	3	Midnight–3 a. m.			900	Thundersquall	Several barns and outbuildings damaged; shocks of grain blown down.
Ida County, Iowa	4	4 p. m.			8,000	Hail	Loss to crops.
Prescott to Emmet, Ark.	4	1:40 p. m.			1,250	Wind	Several buildings unroofed; plate-glass window broken.
Helena, Mont.	5	3:15 p. m.	[1] 1		4,000	Wind and dust	2 persons injured; damage to power lines and buildings; path several miles long.
Kilgore, Tex.	5	5 p. m.	[1] 1		18,000	Straight-line wind	Damage to oil field equipment and baseball park.
Navarro County (north portion) and Hill County (south portion), Tex.	5	5:30 – 8:30 p. m.	[1] 15		590,500	Wind	Loss to crops, $500,000; property damage, $90,500; path 50 miles long.
Vlastence, Tex.	5	6 p. m.			3,500	Hail	Crop loss, $2,500; damage to barns and livestock killed, $1,000.
Falls City, Tex.	5	6:30 p. m.	1,200	0	4,000	Tornado	Property damage, $3,500; crop loss, $500.

[1] Miles instead of yards.

[2] From press reports.

TABLE 4.—*Severe local storms, August 1937*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Sioux City, Iowa [3]	5	P. m.			$2,000	Wind	Damage to electric power lines; plate-glass windows blown in; trees blown down; fireman injured by a live wire.
Frankfort, Kans.	5	do.				do.	Power lines, windows, and trees damaged.
Stuart, Iowa, and vicinity	6	1 a. m.				Electrical and hail.	Farmhouse and barn burned; several cattle killed.
Buffalo, N. Y.	6				20,000	Wind, rain, and hail.	Property damaged.
Salamanca, N. Y.	6				20,000	Rain and hail	Loss to crops, $5,000; telephone lines and buildings damaged.
Evansville, Ind., vicinity of	7	5:10 p. m.	[1] 1		2,000	Hail	Loss to fruit and vegetable crops; path 1 mile long.
Dayton, Ohio, and vicinity	7	11:42 a. m.–5:15 p.m.			120,000	Electrical and hail.	17 houses and an electric car struck by lightning; 2 barns destroyed; telephones disabled. $50,000 loss to Dayton Power & Light Co.
Mills County, Iowa	7	P. m.		0		Tornado	Several small buildings unroofed and chimneys blown down.
Park Rapids, Minn., and vicinity.	7–8				40,000	Thunderstorm	Buildings and trees damaged; loss to growing crops.
Brooklyn, Ind., and vicinity	8	1–5 p. m.			100,000	Electrical	Kiln, brickyard, and barn destroyed by fire.
Lake James, Ind.	8	1–5 p. m.			2,000	Thundersquall	Seaplane overturned and damaged.
Jefferson, Iowa, and vicinity	8					Electrical and rain.	Barn destroyed.
Syracuse, N. Y.	8					do.	Streets and cellars flooded; 21 employees of the Gray Steel Corporation shocked when the plant was struck by lightning.
Dayton, Ohio	9	3:50–4:25 a. m.			500	Squall	Damage to trees and houses.
Chickasaw County, Iowa	9	5 a. m.			8,500	Hail	Loss to crops.
Marysville and Waterville, Kans.	9	4 p. m.				Wind and hail	Large shed of the Civilian Conservation Corps demolished; several residences and other buildings damaged. Hail stripped leaves from corn.
Cullman County, Ala., northwest portion.	9		[1] 6		65,000	Hail	Damage mainly to crops; path 6 miles long.
McPherson, Kans [3]	10	P. m.				Wind and rain	House damaged. Large garage roof carried 50 yards and left in a nearby field.
Moreland, Ark., and vicinity	10		[1] 1½		10,000	Wind and heavy hail.	Several barns and outbuildings destroyed; other buildings damaged.
Gouverneur, N. Y.	10				10,000	Electrical	House and barns destroyed.
Groton, N. Y.	10				8,000	do.	2 barns burned.
Corry, Pa., and vicinity	10					Rain and flood	Roads, streets, and bridges damaged.
Cherokee, Iowa, and vicinity	10–11	P. m.			10,200	Hail	Windows in greenhouses broken and signs down. Property damage, $1,400; crops loss, $8,800.
New York State, west portion	10–11	do.			50,000	Heavy rains	Creeks flooded with considerable damage in a few localities. At Silver Creek an overflow of muddy water drove many families from their homes. 2 reservoirs broke; several cattle drowned. Railroad tracks undermined; several small bridges carried away or ruined.
Muncie, Ind.	11	4–6 a. m.	[1] 5		20,000	Wind and hail	Loss in corn and tomato crops; shrubbery damaged; trees blown down; automobile tops punctured; windows broken.
Blandinsville, Ill.	11				20,400	Hail and wind	Loss to crops, $20,000; property damage from wind, $400.
Casey, Ill.	11				500	Wind	Property damaged.
Centralia–Walnut Hill, Ill.	11				7,000	Hail and wind	Loss principally to peach crop.
Lincoln, Ill.	11				32,500	Wind	Property damage, $25,000; crop loss, $7,500.
McLean, Ill.	11				25,000	Wind and hail	Loss principally to corn crop.
Springfield, Ill.	11				10,000	Wind	Property damage.
Talulla, Ill.	11				3,000	Hail	Loss to crops.
Parke County, Ind.	11	P.m.			1,300	Electrical	Barns and contents destroyed.
Highland County, Ohio, east portion.	11	P.m.				Wind and hail	Several thousand dollars' loss in corn and tobacco; buildings and trees damaged.
Shelby County, Iowa	11				2,500	do.	Loss to crops.
Detroit, Mich.	11				2,000	Thunderstorm	Basements flooded; several transformers struck by lighting.
Hammond and Kellogg, Minn., and vicinity.	11				2,000	Rain and flood	200 feet of railroad track washed out; lowlands inundated; loss to growing crops.
Indianapolis, Ind., vicinity of	11–12	10 p. m.–3 a. m.			2,000	Electrical	Barn destroyed.
Kimball, Nebr., vicinity of	12	4 p. m.	[1] 1½		10,000	Hail	Property damaged.
Westcliffe, Colo., vicinity of	12				8,000	Heavy hail	Loss to crops.
Whitesboro, Tex.	13	Afternoon.			1,000	Wind	2 churches and a cotton gin damaged.
Blaine County, Mont.	13	7–8:30 p. m.	[1] 6–8		10,000	Hail and wind	Small buildings destroyed; crop loss from hail, $10,000; path 80 miles long.
Fulton, Miss.	13	9 p. m.			5,000	Electrical	Buildings damaged.
Chinook, Mont., vicinity of	14					Hail	Considerable damage to truck.
Bismarck, N. Dak.	14					Wind and rain	Trees and several buildings damaged.
Worth County, Iowa	16		880		2,650	Wind and hail	Silo blown down; loss to crops, $2,500; path 8 miles long.
Flint, Mich., vicinity of	17				15,000	Wind	Damage to planes and hangar at the airport.
New York State, north portion	17				6,000	Electrical	5 barns burned.
Ludlow Island, Minn.	18	3 p. m.				Tornadic winds	Large recreational building at the Resettlement Camp moved about 15 feet; 8 tents blown down; roof of warehouse blown off; 1 person injured.
Palo Alto County, Iowa	18	7 p. m.			6,000	Wind and hail	Crop loss from wind, $5,000; property damage, $1,000.
Meriden, Iowa, vicinity of	18					Hail	Much crop loss; some fields badly washed.
Potsdam, N. Y.	19				10,000	Electrical	2 barns burned.
Watertown, N. Y.	19					do.	Garage and automobile salesroom burned; amount of loss not estimated.
New Hampton, Iowa, vicinity of	20	P. m.		0		Tornado	Stacks of timothy on one farm scattered over an adjoining field. No other damage.
Tucson, Ariz.	20				2,000	Tornadic winds	Buildings damaged.
Canton, N. Y., and vicinity	20					Thundersquall	Flagpole on the Weather Bureau building and trees blown down; several barns burned.
Chappells, S. C., vicinity of	21	2 p. m.			750	Electrical	3 mules killed in a barn.
Evansville, Ind.	22	P. m.				Heavy rain	Sewers inadequate; water 3 feet deep in streets; hundreds of automobiles stalled.
Clark County, S. Dak.	24	5:30–6 p. m.	440		1,500	Wind	Farm buildings wrecked.
Plymouth County, Iowa	24	9:25 p. m.				Hail	In some spots crops were a total loss.
Columbia, S. C.	25	1:30 p. m.			1,000	Electrical	Fire in a warehouse destroyed bales of cotton stored in the basement.
Wheaton, Minn.	25	6 p. m.	[1] 2	1	10,000	Tornado and hail.	Number of farm buildings damaged or demolished; corn badly twisted or lodged in places; path 4 miles long.
New York State, south-central portion.	26–27				250,000	Rain and flood	Unusually heavy rains caused severe flood conditions. Highways and bridges washed out; many homes and streets flooded.
Wellsboro, Pa.	27				550,000	Flood	Marsh Creek overflowed its dike causing property loss at over half a million. Loss to crops and farms, $50,000.

[1] Miles instead of yards.

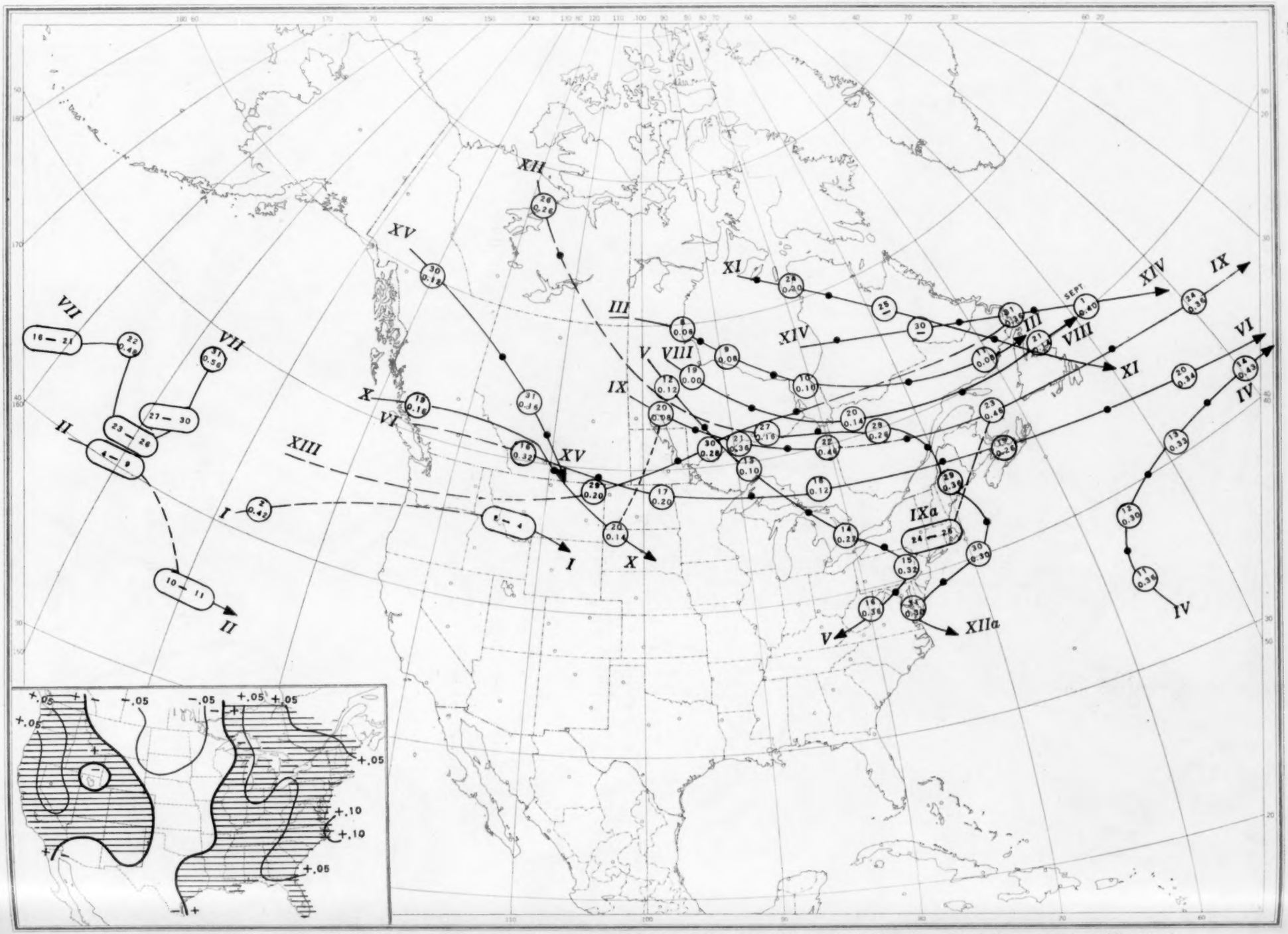
[3] From press reports.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, August 1937

Chart I. Departure (°F.) of the Mean Temperature from the Normal, August 1937

Chart II. Tracks of Centers of Anticyclones, August 1937. (Inset) **Departure of Monthly Mean Pressure from Normal**

(Plotted by W. P. Day)



Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

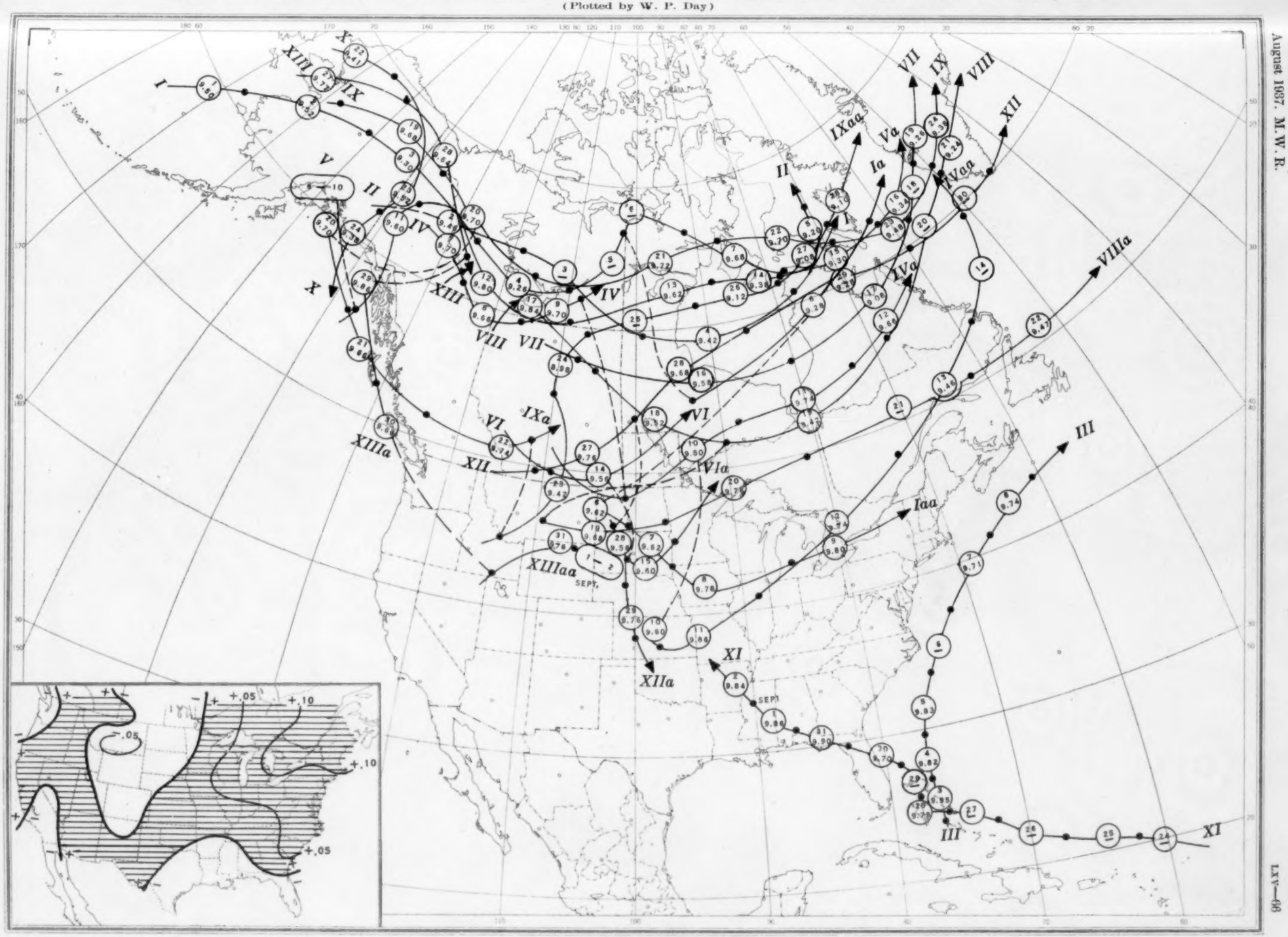
Chart III. Tracks of Centers of Cyclones, August 1937. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by W. P. Day)

Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, August 1937. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by W. P. Day)



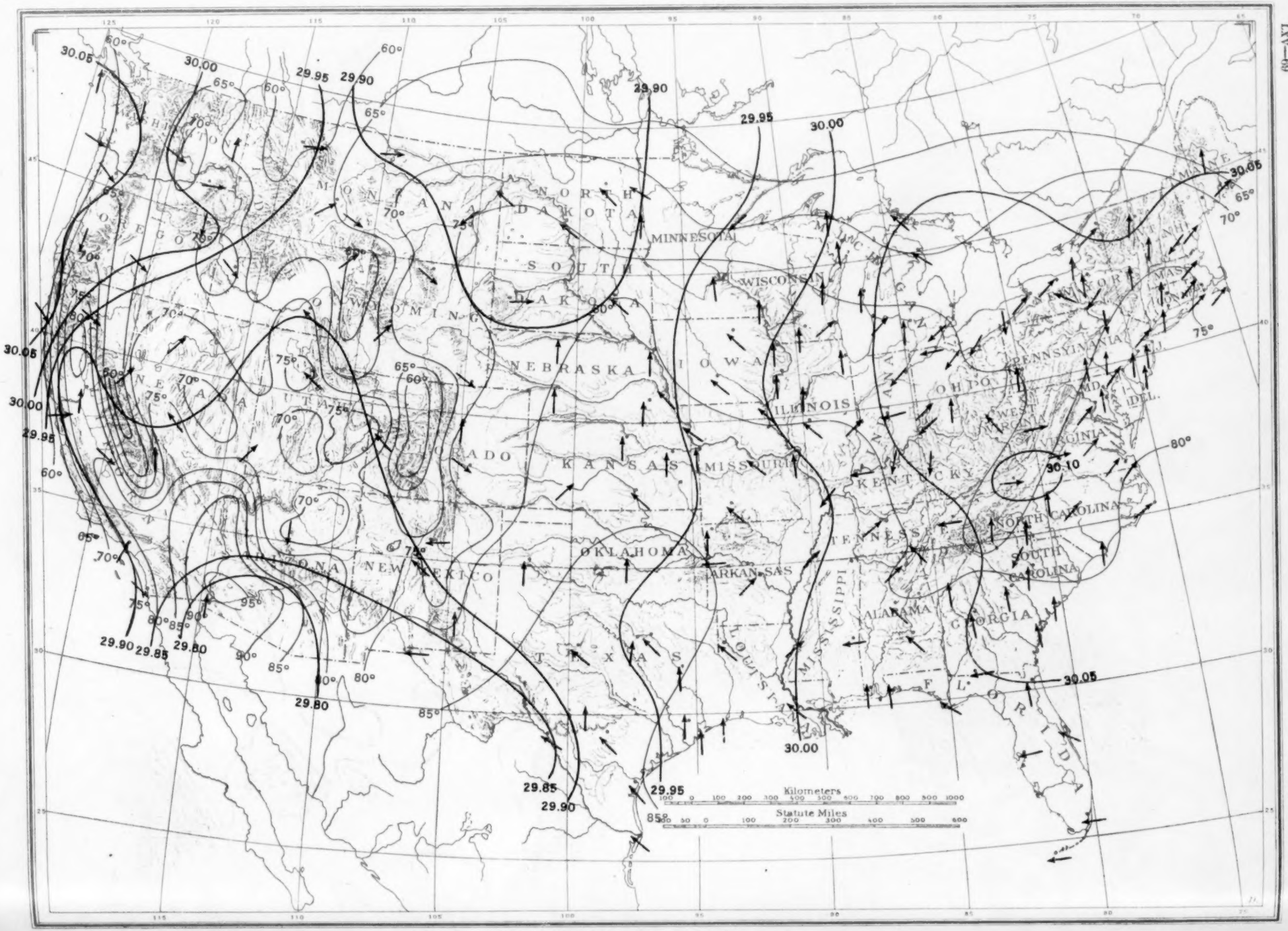
Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, August 1937

Chart V. Total Precipitation, Inches, August 1937. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, August 1937. (Inset) Departure of Precipitation from Normal

Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, August 1937



(Plotted by W. W. Reed)

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